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March 1996

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Meteorological Satellites (METSAT) and Earth Observing System (EOS) Advanced Microwave Sounding Unit-A (AMSU-A) Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL)

Contract No: NAS 5-32314
CDRL: 108 and 507

Submitted to:

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Submitted by:

Aerojet
1100 West Hollyvale Street
Azusa, California 91702

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Section 1

INTRODUCTION

This *Failure Modes and Effects Analysis (FMEA)* is for the Advanced Microwave Sounding Unit-A (AMSU-A) instruments that are being designed and manufactured for the Meteorological Satellites Project (METSAT) and the Earth Observing System (EOS) integrated programs. This FMEA analyzes the design of the METSAT and EOS instruments as they currently exist. This FMEA is intended to identify METSAT and EOS failure modes and their effect on spacecraft-instrument and instrument-component interfaces. The prime objective of this FMEA is to identify potential catastrophic and critical failures so that susceptibility to the failures and their effects can be eliminated from the METSAT/EOS instruments.

As described in Section 7, the instrument is partitioned into an Antenna Subsystem (AS), a Receiver Subsystem (RS) and an Electronics Subsystem (ES). The subsystems are partitioned into an A1 module and an A2 module. The Antenna and Receiver Subsystems are common for METSAT and EOS except for a compensation assembly in the Antenna Subsystem A2 Module (A2AS). Reliability block diagrams are provided for the METSAT Electronics Subsystem A1 Module (A1ES-METSAT), and the A2 Module (A2ES-METSAT), the EOS Electronics Subsystem A1 module, and the A2 module (A2ES-EOS). A summary of this indexing is shown in Table I.

Table I Component Summary Index

AMSU Component	Index
METSAT/EOS Common	
A1 Module Antenna Subsystem	A1AS
A2 Module Antenna Subsystem	A2AS
A1 Module Receiver Subsystem	A1RS
A2 Module Receiver Subsystem	A2RS
METSAT Unique	
A1 Module Electronics Subsystem	A1ES-METSAT
A2 Module Electronics Subsystem	A2ES-METSAT
EOS Unique	
A1 Module Electronics Subsystem	A1ES-EOS
A2 Module Electronics Subsystem	A2ES-EOS

1.1 *Scope*

This is an integrated report that documents both the FMEA and Critical Items List (CIL) results (attached as Appendix B) for the METSAT and EOS instruments and has been prepared and submitted in accordance with contract NAS 5-32314, Contract Document Requirements List (CDRL) items 108 and 507, respectively. This report meets the requirements of 7.3.1 of the Performance Assurance Requirements document GSFC-S-480-79 and has been prepared in contractor format using Flight Assurance Procedure FAP P-302-720 as a guide.

1.2 *Purpose*

This is the final submittal of the FMEA and CIL. It will be updated as necessary if new or modified failure modes are identified because of changes in the design or changes in the safety or mission performance requirements.

Section 2

SUMMARY OF RESULTS AND CONCLUSIONS

2.1 *METSAT/EOS Results*

The FMEA process started with NASA contract NAS 5-29402 for the K-L-M instrument, and the results from this FMEA were reported March 1990, Report 8183-2. This report was first revised and updated for the EOS AMSU-A instrument as NASA Preliminary Report 10378, dated August 1994. This FMEA METSAT/EOS updated report 10378 has been revised to include FMEA results for both METSAT and EOS AMSU-A instruments. Table II provides METSAT changes from K-L-M. Differences between EOS and METSAT instruments are discussed in 7.2 and 7.3 herein.

Table II AMSU-A METSAT Changes From K-L-M

Item	Change	Reason for Change
A1 Upper Card Rack	Changed from 4 CCA to 2 CCA (2 motor driven CCA).	Power Control Logic and Analog Housekeeping CCA combined for improved reliability
A1 Lower Card Rack	New Relay Driver CCA added, requiring shifting of other cards one slot.	Repositioning of cards to minimize risk of crosstalk and maximize interconnect efficiency.
A2 Card Rack	2 CCA deleted, 1 CCA added, 7 CCA shifted 2 slots in card rack.	Repositioning of cards to minimize risk of crosstalk and maximize interconnect efficiency.
Motor Drive Transistors	Were bulkhead mounted and hard-wired, now are integral part of cable assembly as transistor/diode assembly	Wired as part of cable assy to eliminate wiring at system level, combined with transient suppression diodes on assy for best performance.
DC-DC converter	New design	Power requirements changed because of change from GDO to DRO in receiver and new supplier.
System Interconnect	New connectorized harness	Reduce system noise and reduce integration and test time.
CPU CCA	Different RAM used and additional clock buffering added.	A. RAM discontinued B. Buffer drive margin added
Analog MUX and A/D CCA	Part of radiation latchup removal redesigned.	Dual PNP transistor no longer available.
Motor Driver CCA	Current and gain limiter resistors moved to power relay assembly. Diodes moved to Transistor/Diode assy.	Removes motor drive current from A2 card cage to minimize system noise, A1 modified for commonality.
Power Control Relay and Analog Housekeeping CCA	No longer used.	High current functions in A1 upper card cage moved to new Power Relay Assembly and to new Relay Driver CCA.
28V Switching Assy and Power Distribution Terminal Boards	No longer used.	Functions now contained in new Power Relay Assembly.
PLO Relay	Moved from deleted Power Control Logic CCA to Receiver shelf.	CCA deleted

2.1.1 *Potential Failure Modes Problem Areas*

The CIL provided in Appendix B is a list of failure modes identified by their criticality to system operations and additional problem areas that have been identified.

2.1.2 *Items Exempted from the FMEA*

Software and its effect on system operation was not analyzed in this FMEA.

2. 2 *Conclusions*

This report reflects the identified failure modes related to the METSAT/EOS instruments as they currently exist. Design analysis is pending for a potential loss of signal processing (and other functions) caused by a short on the output of the DC/DC converters. All other identified failure modes are considered acceptable operational risks.

The METSAT/EOS AMSU-A instruments have one redundannt circuit. This circuit provides redundant 57.290344GH$_Z$ PLO for channels 9 through 14 (see Figure 13). Only one PLO is active during operation, and switching is provided by a latching relay, having two coils, one for each position of the contacts. One contract position selects the primary PLO, the other position selects the redundant PLO.

Section 3

REFERENCE DOCUMENTS

The following documents were used in the preparation of this FMEA Report.

SPECIFICATIONS

Goddard Space Flight Center Documents

GSFC-S-480-80 Dec 1994	Performance and Operation Specification for the EOS/METSAT Integrated Programs AMSU-A Instrument (POS)
GSFC-S-480-79 Oct 1994	Performance Assurance Requirements for the Earth Observing System (EOS) and Meteorological Satellites Project (METSAT) Advanced Microwave Sounding Units - A (PAR)
GSFC 422-11-12-01	General Interface Requirements Document for EOS Common Spacecraft/Instruments - EOS PM Project (GIRD)
GSFC 422-12-12-02	Unique Instrument Interface Document for the AMSU-A-EOS Project (UIID)
GSFC FAP P-302-720	Flight Assurance Procedure for Performing a Failure Mode and Effects Analysis

Aerojet Document

AE-26607 Mar 1996	Subsystem Specification AMSU-A Antenna
AE-26608 Mar 1996	Subsystem Specification AMSU-A Receiver
AE-26609 Mar 1996	Subsystem Specification AMSU-A Electronics

Section 4

DEFINITIONS

The following definitions apply to this FMEA:

4.1 *Assembly*

A number of parts or subassemblies or any combination thereof joined together to perform a specific function and capable of disassembly (e.g., radio frequency amplifier, bearing assembly).

4.2 *Compensating Features*

Compensating features are special inspections, tests, controls, instructions, drawing notes, or other provisions applied to a single-point-failure mode item to improve or enhance reliability.

4.3 *Component*

Assembly or any combination of parts, subassemblies, and assemblies, mounted together, normally capable of independent operation in a variety of situations (e.g., electric motor, electronic power supply, thruster, radio receiver). Note: The size of an item is a consideration in some cases. An electric motor for a clock may be considered as a part, as it is not normally subject to disassembly. A component is not a part. See equivalent term of unit.

4.4 *Correlated or Sympathetic Failure*

The inability of two (or more) redundant items to perform their function as the result of some single event, thus possibly negating the redundancy and acting as a single-point-failure mode (SPFM); e.g., loss of a raceway containing redundant power leads or a pyrotechnic shock causing parallel relays to chatter.

4.5 *Failure*

The inability of an item to perform within previously specified limits.

4.6 *Failure Effect*

The consequence of the failure mode including primary and secondary effects.

4.7 *Failure Cause*

The cause of the failure mode.

4.8 *Failure Mode*

The way or manner in which an item fails.

4.9 *Item*

A nonspecific term used to denote any product, including systems, materials, parts, subassemblies, sets, accessories, etc.

4.10 *Part*

One piece, or two or more pieces joined together that are not normally subject to disassembly without destruction of designed use (e.g., transistor, integrated circuit, screw, gear, transformer).

4.11 *Single-Point Failure (SPF)*

Any piece part, assembly, component, or element of construction, such as printed circuit board layout, the failure of which would result in irreversible degradation of item mission performance below contractually specified levels, such as failure of an item in operation which could be catastrophic to a mission objective. (A SPFM is a single-point-failure mode.)

4.12 *Subsystem*

A combination of components which performs an operational function within a system and is a major subdivision of the system.

4.13 *System*

A composite of equipment, skills, and techniques capable of performing or supporting an operational role, or both. A complete system includes all equipment, related facilities, material, software, services, and personnel required for its operation and support to the degree that it can be considered a self-sufficient item in its intended operational environment. The term system is used to refer to the highest level of requirements and resource grouping applicable to the particular contract and analysis.

4.14 *Unit*

See the equivalent term component. For the purposes of this document, the terms may be interchanged; the term commonly used in a particular program should be used to reduce ambiguity.

Section 5

ABBREVIATIONS/ACRONYMS

Abbreviations/Acronyms

A/D	Analog/Digital
Amp	Amplifier
AMSU	Advanced Microwave Sounding Unit
Attn	Attenuator
BPF	Bandpass Filter
Calib	Calibration
CCA	Circuit Card Assembly
CMOS	Ceramic Metal Oxide Semiconductor
CPU	Central Processing Unit
DET	Detector
EOS	Earth Observing System
FIFO	First In, First Out
GFSC	Goddard Space Flight Center
GIRD	General Interface Requirements Document
IF	Intermediate Frequency
ISO	Isolator
I&D	Integrate and Dump
LO	Local Oscillator
METSAT	Meteorological Satellites
MUX	Multiplexer
PLO	Phase-Locked Oscillator
PRT	Platinum Resistance Thermistor
RAM	Random Access Memory
R/D	Resolver/Digital Converter
SAW	Surface Acoustic Wave
TCG	Timing Control Generator
Typ	Typical
UIID	Unique Instrument Interface Document

Section 6

FMEA DESCRIPTION

6.1 *General procedure*

6.1.1 *Failure Modes and Effects Analysis Methodology*

This submittal of the *Failure Modes and Effects Analysis (FMEA)* of the EOS and METSAT Advanced Microwave Sounding Unit-A (AMSU-A) is the result of analyzing the design as it currently exists. This FMEA was prepared using GSFC FAP P-302-2-720 as a guide. In this analysis, we have first conducted a system interface FMEA. This analysis identifies and analyzes the interface between the AMSU-A Modules A1 and A2 and the spacecraft. These interfaces include thermal, electrical, mechanical, communication, telemetry, and command and control. The FMEA is based on engineering judgment of the failure modes that could be encountered in the critical AMSU-A-to-spacecraft interface. Failures in any one of the subsystems that could cause thermal, electrical, or mechanical damage or degradation to any of the other two subsystems is reviewed in this FMEA.

6.1.2 *FMEA Worksheets*

Appendixes A and B contain the FMEA worksheets for the AMSU-A. The column headings are as follows:

a.	Identification Number	A serial number or other reference designation identification number assigned for traceability purposes.
b.	Item/Functional Identification	The name or nomenclature of the item or system function being analyzed.
c.	Function	A concise statement of the function performed by the hardware item.
d.	Failure Modes	Describes the known or possible ways the item can fail.
	Failure Causes	Describes the physics of the failure.
e.	Mission Phase/ Operational Mode	A concise statement of the mission phase and operational mode in which the failure occurs.
f.	Failure Effects	
	Next Higher Level	Effect of the failure mode on the next higher assembly.
	Mission Effects	Immediate or long-term effect on the AMSU-A mission.
g.	Failure Detection Method	Self explanatory. In general, failures will be detected by examining the telemetry equipment status data and the serial output data stream.

h.	Compensating Provisions	Those steps taken to minimize frequency and severity on the AMSU-A mission.
i.	Severity Class	Classification of the consequences of a failure mode.
j.	Failure Probability	Qualitative evaluation which roughly corresponds to preliminary reliability estimates.

These worksheets are provided in Appendix A.

The failure probability or failure rate is designated as frequent, reasonably probable, occasional, remote, or extremely unlikely. Assignments are on the basis of the mean-time-between-failure (MTBF), in hours, for this design. The following scale was used as a guide:

Probability of a single-failure mode which is:

P > 0.20	0.10 <P> 0.20	0.01 P < 0.10	0.001 P < 0.01	P < 0.001
Frequent	Reasonably Probable	Occasional	Remote	Extremely Unlikely

P = the overall probability of failure during the operational time interval (3 years).

6.1.3 *Severity Levels*

Identification of mission-critical items is provided on each worksheet by assigning a severity category to each failure mode. The severity classifications are as defined in GSFC-S-480-79, Paragraph 7.3.1.

I	Criticality 1. A single failure that could result in loss of human life or serious injury to personnel, or loss of a launch facility, the launch vehicle, or a primary mission objective. (For failures involving potential loss of life or serious injury to personnel, redundant design, both of which if failed would result in a Criticality 1 failure, shall be considered Criticality 1.)
II	Criticality 2. A single failure that could result in damage to a launch facility or launch vehicle, significant degradation of science products (as defined by the Project), or loss of a secondary mission objective.
III	Criticality 3. Loss of redundancy or an effect less severe than that of a Criticality 2 failure mode.

6.1.4 *Mission Profile*

A mission time of 3 years operation in space with a goal of 5 years is used as specified by GSFC, with no maintenance or repair.

6.2 *Ground Rules and Assumptions*

The analysis is based on the following:

a. Neither the METSAT nor the EOS is energized until the desired orbit is achieved (except for pre- launch testing).

b. This analysis applies to the normal operating mode.

c. Failure modes and causes are all time-independent. That is, there are no failure modes nor applicable corrective actions that relate to time as a factor.

d. There are no symptoms and warnings prior to failure occurrence. There may be exceptions to this, but they are very few.

e. The ground rules for failure selection are as follows:

1. Only one failure will be considered at a time.

2. Redundant elements will be analyzed on the basis of the effect of a failure upon operation of the redundant network.

3. As a general rule, the classification of failure modes conforms to the following:

a) Open part or circuit

b) Short part or circuit

c) Degradation of circuit(s), less than required for normal performance

d) Output voltage stuck high

e) Output voltage stuck low

f) Low power

g) Excessive wear

h) Outputs above or below limits

i) Temperature rise/overheating

The assignment of failure modes was developed to conform with the normally accepted failure modes of the item under evaluation; e.g., capacitors typically fail open or shorted, most semiconductors can be either an open or short failure, digital circuits usually get stuck high or low.

6.3 *Indentured Levels Analyzed*

The indentured level analyzed is the component level. The components of the AMSU-A instrument are the Electronics Subsystem, Receiver Subsystem, and the Antenna Subsystem. Within these subsystems are two functionally partitioned modules identified as AMSU-A1 and AMSU-A2 (identified as

A1 and A2 herein). The definition and functional description of these components is provided in Section 7.0 herein. This FMEA identifies potential failure modes for interfaces between these components and the interface from modules A1 and A2 to the spacecraft. Cause of potential failures is identified to the failed part. As identified for this FMEA, parts of the components are listed at the level shown in the Reliability Block Diagrams (see paragraph 7.4 herein).

Table III provides descriptions for the Electronic Subsystem parts (CCA) that are the interface between the spacecraft and all active functions of the AMSU-A instruments.

Table III Description of Subsystem Parts

Assembly Dwg. Number	Schematic Number	Title	Description
1338421 1331682	1338423 1331683	Temperature Sensor Board A Temperature Sensor Board B	Conditions temperature signal for input to Multiplexer
1331688	1331689	Temperature Sensor, Analog Mux	Combines temperature signals in a multiplexer
1356413	1356414	Central Processing Unit	Uses microprocessor to control whole system
1331126	1331127	Memory	Contains ROM
1331129	1331130	Scan Control Interface	Provides timing, control, and address signal
1331135	1331136	Timing and Control	Interface between CPU and antenna
1356418	1356419	Analog Multiplexer and A/D Converter	Multiplexes radiometric channels and temperature sensor data and quantizes the analog data to 15 bits
1338424	1338426	Integrate and Dump Filter	Provides the final post-detection filter for the radiometric channels
1331694	1331695	Motor Driver, 3 Hall Sensor	Drives antenna motors
1331697	1331698	Interface Converter	Performs digital logic functions and digital to analog conversions
1334972	1334974	Resolver Data Isolator	Isolates resolver data to digital processor
1337739	1337737	R/D Converter-Oscillator	Converts analog resolver signals to digital signals and produces 1600 Hz for resolver
1331157	1331158	Video Preamplifier, 3-Channel	Amplifies output of detector
1331074	1331075	Video Preamplifier, 2-Channel	Amplifies output of detector
METSAT Only			
1331150	1331151	Parallel to Serial Converter	Converts format from parallel to serial
1331144	1331145	Spacecraft Interface #1	Provides all communication between spacecraft and instrument
1331148	1331148	Spacecraft Interface #2	Provides all communication between spacecraft and instrument
1356911	1356912	Relay Driver/Current Monitor	Relay driver and motor current monitoring circuits
1356969	1356908	Power Relay and Housekeeping	Power relays and voltage dividers
EOS Only			
1356000	1355999	Mux Relay Control	Multiplexes engineering data and provides control signals to drive relays for scan power and PLO switching
1355998	1355997	MIL-STD-1553 Interface	Provides all communication between spacecraft and instrument
1356760	1356001	Power Control/Monitor and Monitoring Assy.	Distributes power and provides bus selection relays, and voltage dividers for monitoring voltages

Section 7

FUNCTIONAL DESCRIPTION OF METSAT/EOS AMSU-A INSTRUMENTS

The AMSU-A instrument is a multichannel radiometer that will be used for measuring global atmospheric temperature profiles.

The AMSU-A instrument is a line-scan microwave sensor designed to measure scene radiance in 15 channels to permit the calculation of the vertical temperature profile from the surface of the Earth to approximately the 3 millibar pressure height.

The ability of passive microwave sensors to operate in the presence of clouds is the essence of their effectiveness and has led to their development for this AMSU-A instrument.

7.1 *AMSU-A1 and AMSU-A2 Modules*

The AMSU-A instrument is implemented in two separate modules, AMSU-A1 and AMSU-A2. The two lowest frequencies (Channels 1 and 2) are placed into the AMSU-A2. The antenna for AMSU-A2 is much larger, about 12 inches in width; whereas AMSU-A1 uses two smaller antennas, each about 5 inches in width, for Channels 3 through 15.

The basic operation of these two modules is very similar. They use the same approach and techniques to perform their function. Each of these two modules shares many of the same subassemblies, circuit card assemblies, and other items.

Each module is configured in the same fashion, and consists of three major subsystems: (a) antenna subsystem, (b) receiver subsystem, and (c) electronics subsystem. In each module, the basic design of each subsystem is the same, differing only as a result of the specific frequencies.

In the 13-channel module, identified as AMSU-A1, two separate and independent antenna, receiver, and electronic subsystems are integrated into a single common mechanical/structural and thermal subassembly.

7.1.1 *Receiver Subsystem*

7.1.1.1 *Subsystem Description*

The AMSU-A1 Receiver Subsystem is composed of the functional receiver elements and the structural members, called the receiver shelves, required to support the receiver elements and interface to the AMSU-A instrument structure.

The AMSU-1 A1 and AMSU-A2 Receiver Subassemblies are shown in block diagram form in Figures 1 and 2 respectively. The Receiver Subsystem processes fifteen microwave channels. These channels are distributed amongst the receiver shelves as follows:

A1-1 Receiver Shelf	Channels 6, 7, and 9 through 15
A1-2 Receiver Shelf	Channels 3, 4, 5, and 8
A2 Receiver Shelf	Channels 1 and 2

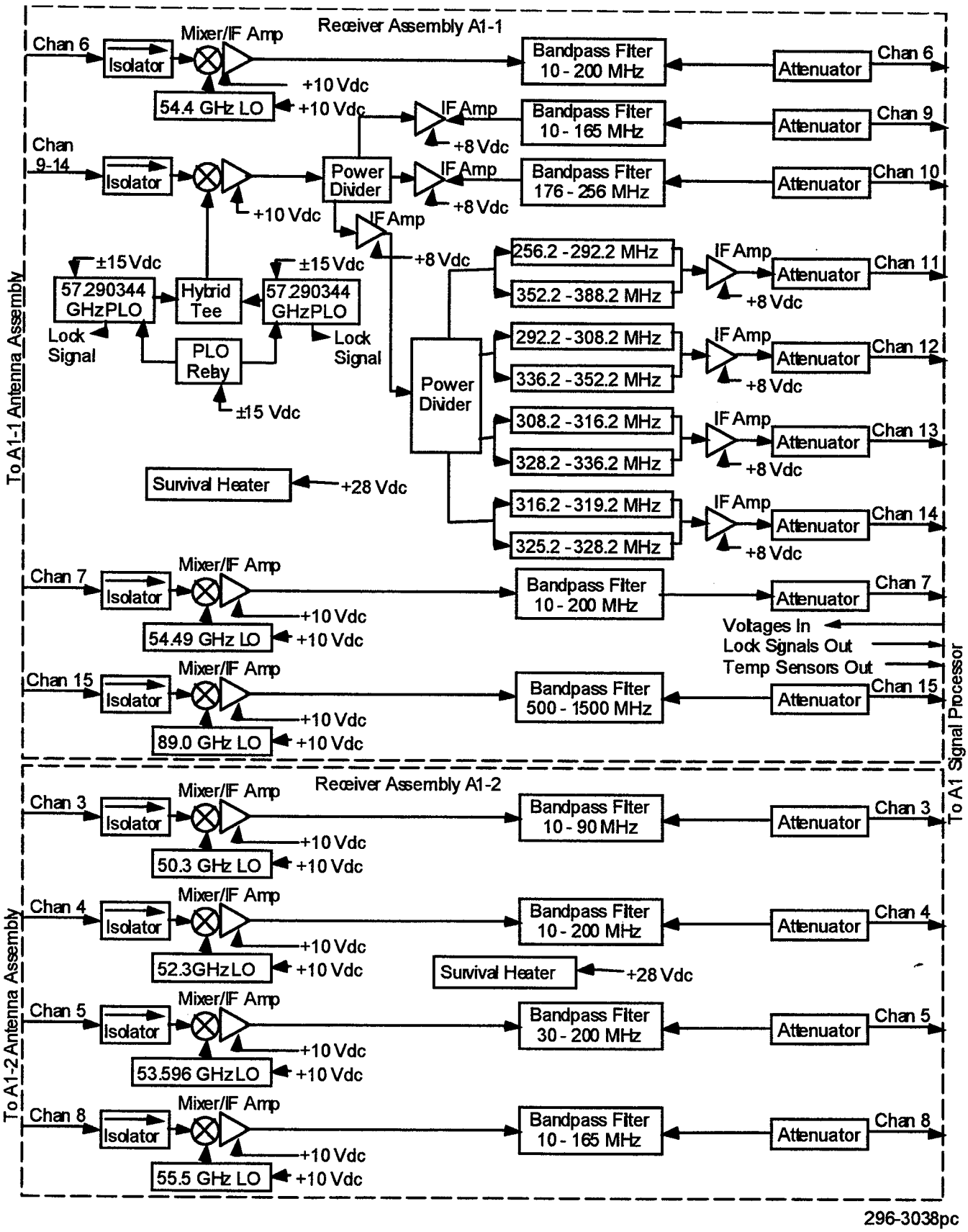


Figure 1 AMSU-A1 Receiver Functional Block Diagram

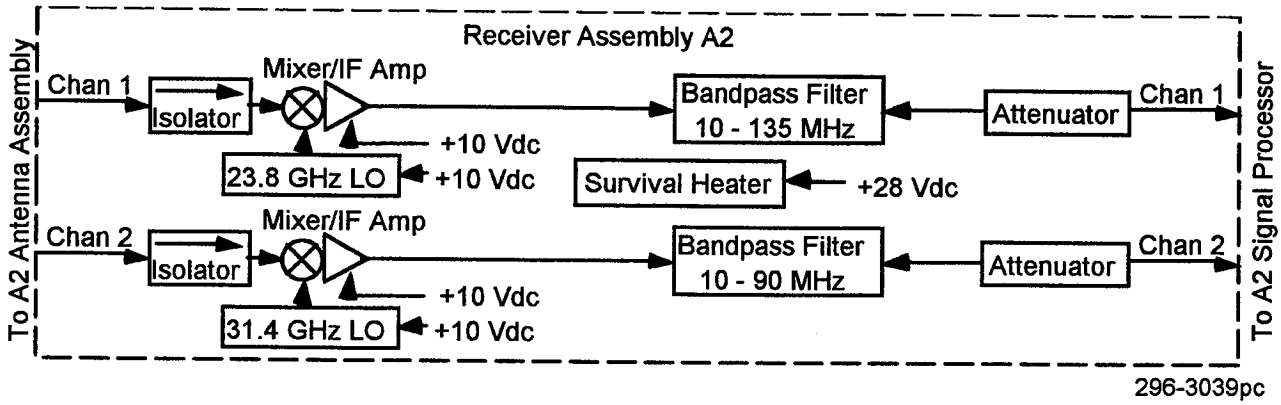


Figure 2 AMSU A2 Receiver Functional Block Diagram

7.1.1.2 *Subsystem Interface Definition*

The Receiver Subsystem functional interfaces are as follows:

Inputs

Microwave signal inputs from the Antenna Subsystem connect directly to the antenna multiplexer output ports via waveguide flange connections.

Voltage inputs from the Power Distribution Assembly of the Electronics Subsystem connect via electrical connectors on each receiver shelf.

Outputs

IF attenuator signal outputs from each channel connect via semirigid coaxial connectors to the Signal Processing Assembly of the Electronics Subsystem.

Temperature sensors and diagnostic sensors connect via electrical connectors on each receiver shelf to the Signal Processing Assembly of the Electronics Subsystem.

7.1.2 *Electronics Subsystem*

7.1.2.1 *Subsystem Description*

The Electronics Subsystem is composed of the electronic elements necessary to provide power, control, commands, data handling, and the electrical interface with the

METSAT and EOS spacecraft for the AMSU-A instrument.

The AMSU-A1 and AMSU-A2 Electronic Subassemblies are shown in block diagram form in Figures 3 through 6. Figures 3 and 4 show the METSAT and EOS AMSU-A1 Electronics Subassemblies respectively. Figures 5 and 6 show the METSAT and EOS AMSU-A2 Electronics Subassemblies, respectively.

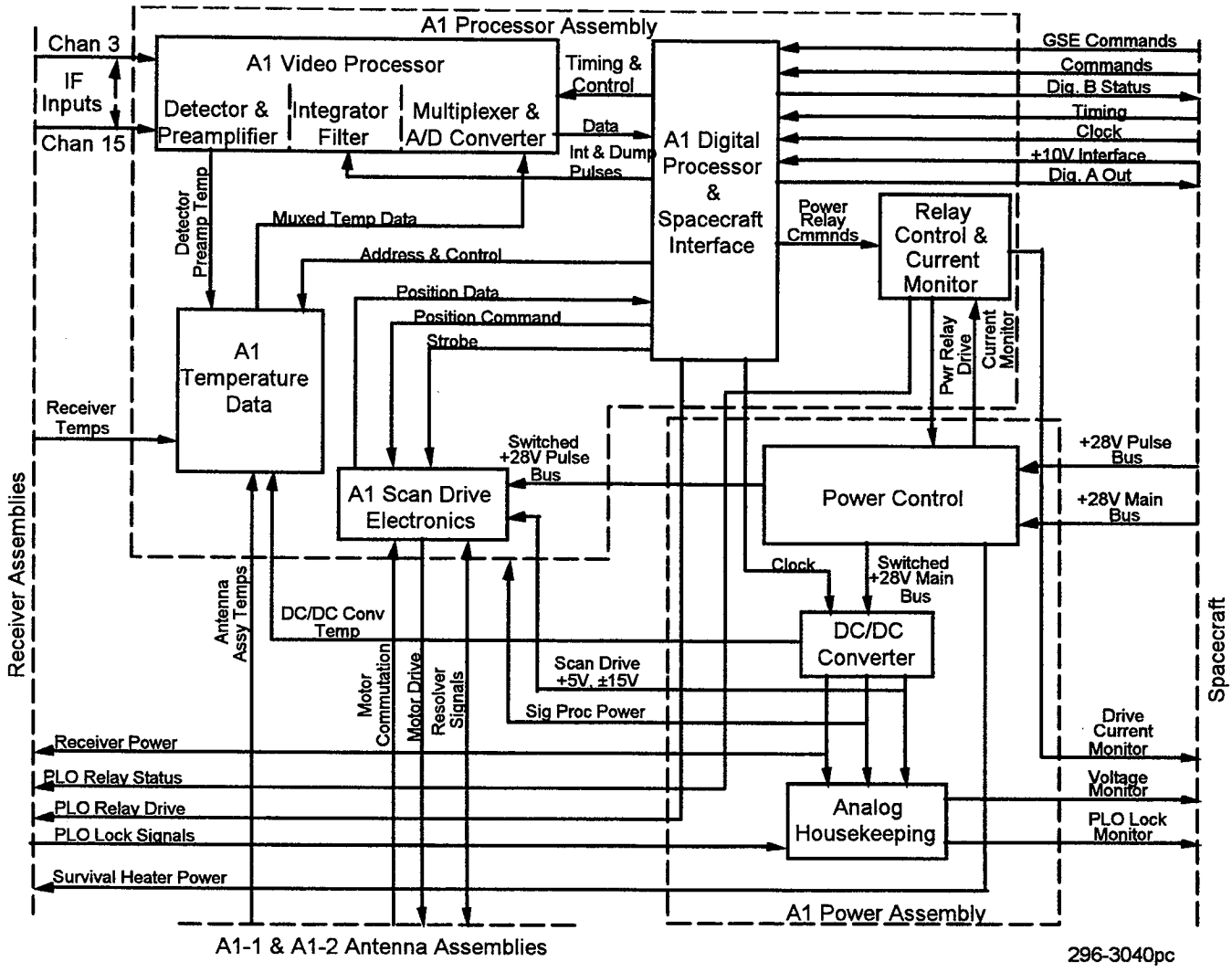


Figure 3 METSAT AMSU A1 Electronics Subassembly

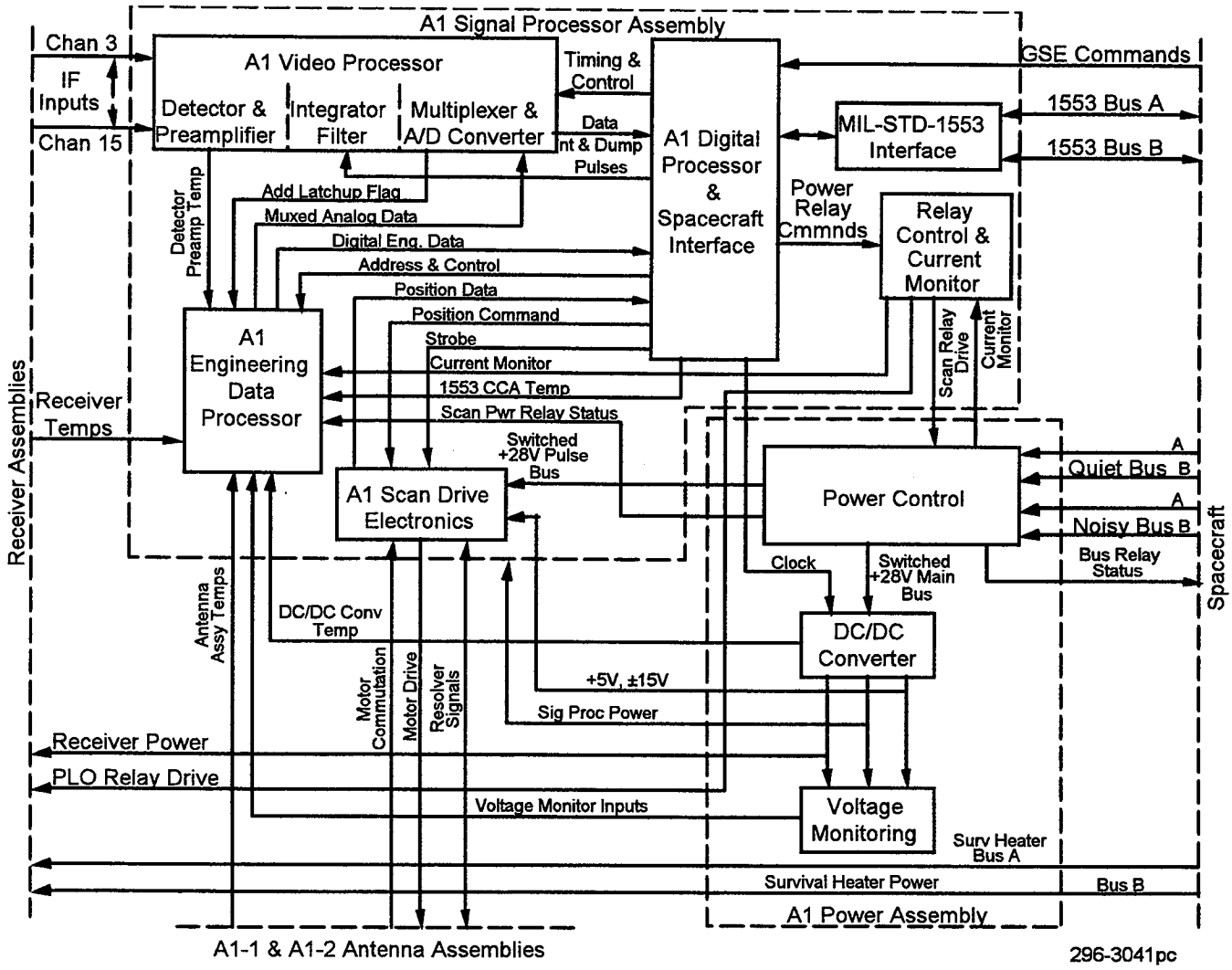


Figure 4 EOS AMSU-A1 Electronics Subassembly

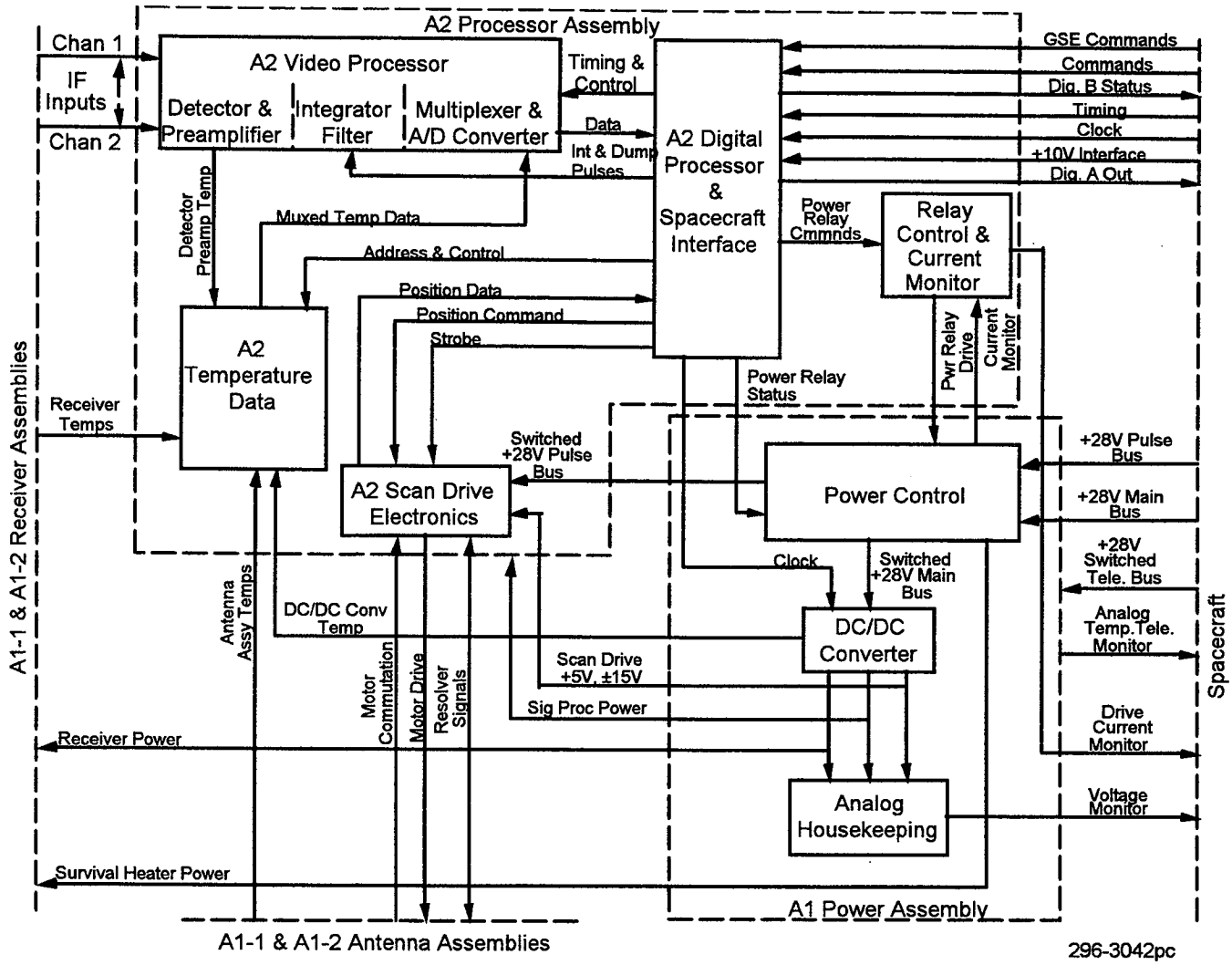


Figure 5 METSAT AMSU-2 Electronics Subassembly

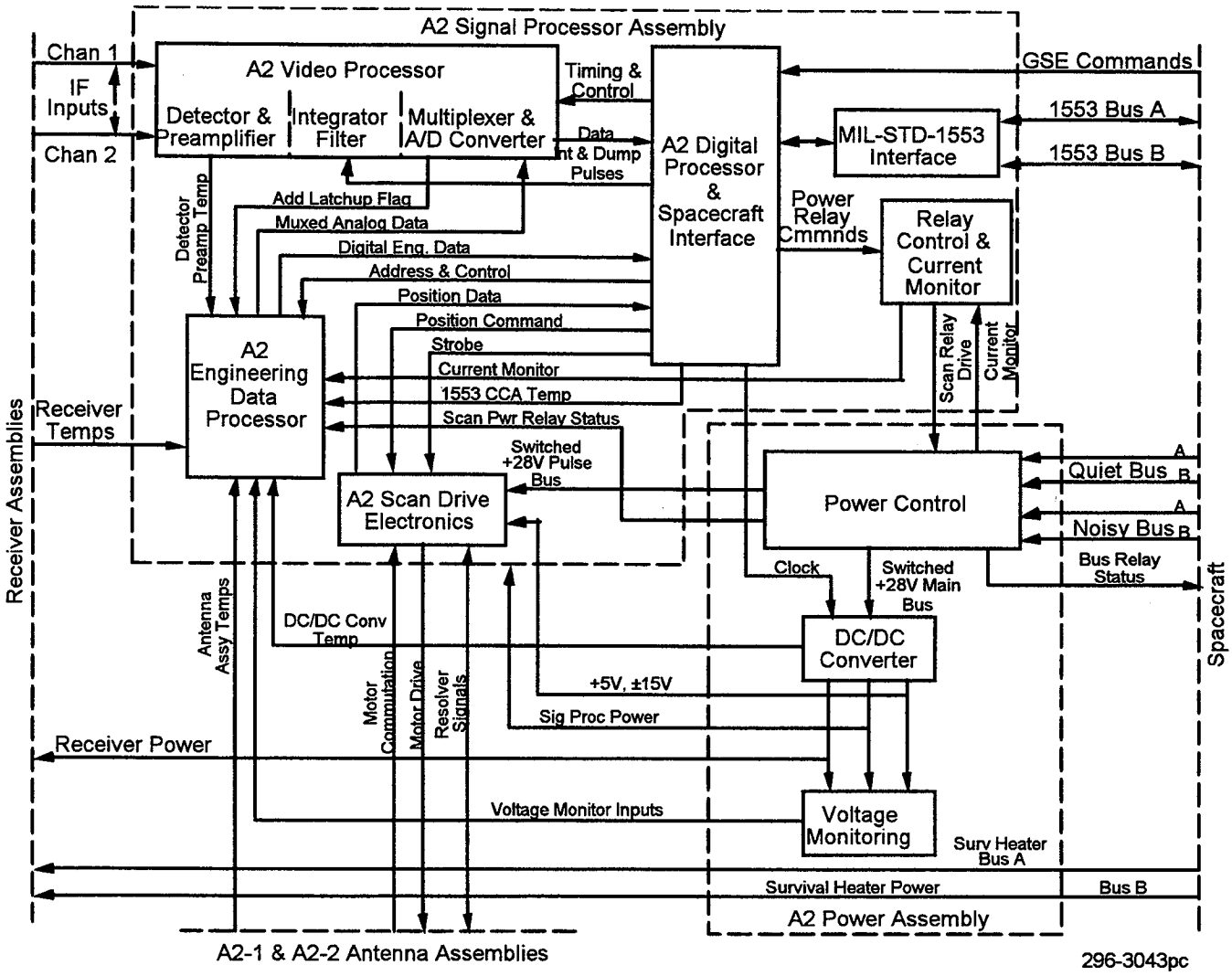


Figure 6 EOS AMSU-A2 Electronics Subassembly

The Signal Processing Assemblies provide video processing of input intermediate frequency (IF) signals, digital processing of the resulting data stream, general control and synchronization of instrument activities, passive analog telemetry circuits and output, scan drive electronics to control antenna position and scan, and data interface control with the METSAT/EOS spacecraft. Each video processor shall provide IF detection, linear preamplification, integration, multiplexing, and digitizing of input signals. The A1 Signal Processing Assembly processes outputs from channels 3 through 15 of the A1 Receiver Subsystem while the A2 Signal Processing Assembly processes outputs channels 1 and 2 of the A2 Receiver Subsystem. Each digital processor provides processor outputs from channels 1 and 2 of the A2 Receiver Subsystem. Each digital processor provides overall control of module operation, receiving commands from the spacecraft and formatting and sending data and status signals, generating timing signals, and providing timing and control signals to and receiving position data from the scan drive electronics. The scan drive electronics converts digital scan control signals to analog motor drive voltages and digitizes antenna resolver output data. Analog circuitry is provided to allow temperature, current, and voltage monitoring of critical instrument elements.

The Power Distribution Assemblies provide distribution and switching of primary spacecraft power to the module subsystems and DC/DC converters in various required operational modes, and a power return and grounding scheme in accordance with METSAT/EOS AMSU-A requirements. The Power Distribution Assemblies also provide distribution and return of the secondary power outputs generated by the DC/DC converters.

7.1.2.2 *Subsystem Interface Definition*

The Electronics Subsystem functional interface is as follows:

Inputs from Receiver Subsystem

IF attenuator signal outputs from each receiver channel connect via semirigid coaxial connectors to the video processing electronics of the Signal Processing Assemblies.

Temperature sensors and diagnostic sensors connect via electrical connectors from each receiver shelf to the Signal Processing Assemblies.

Inputs from Antenna Subsystem

Motor commutation signals from the hall effect sensors mounted on each motor assembly connect via electrical connectors from each Antenna Subassembly to the scan drive electronics of the Signal Processing Assemblies.

Resolver analog position signals connect via electrical connectors from each Antenna Subassembly to the scan drive electronics of the Signal Processing Assemblies.

Temperature sensors connect via electrical connectors from critical antenna components to the temperature conditioning electronics of the Signal Processing Assemblies.

Outputs to Receiver Subsystem

Voltages from the Power Distribution Assembly of the Electronics Subsystem connect via electrical connectors to power each receiver shelf.

PLO relay drive signal from the Relay Control and Current Monitor electronics connect via electrical connector to the Receiver Subsystem.

Survival Heater power passes from the spacecraft to the survival heaters located on each receiver shelf. The Electronics Subsystem has no control over the Survival Heater Bus.

Outputs to Antenna Subsystem

Motor drive signals from the scan drive electronics connect via electrical connectors to move each motor in the Antenna Subsystem.

Resolver drive signals from the scan drive electronics connect via electrical connectors to each resolver in the Antenna Subsystem.

7.1.3 *Antenna Subsystem*

7.1.3.1 *Antenna Subsystem Description*

The AMSU-A Antenna Subsystem is composed of the functional antenna elements, the antenna scan drive motors, the antenna position resolvers, the warm load calibration sources, momentum compensator (METSAT A2 only), and the machined structural housings required to support and align the antenna elements and to mount other elements of AMSU-A.

The A1 and A2 Antenna Subassemblies are shown in block diagram form in Figures 7 and 8 respectively.

7.1.3.2 *Subsystem Interface Description*

The Antenna Subsystem functional interface is as follows:

Inputs

Each reflector collects and focuses microwave radiation into its corresponding feedhorn.

Motor drive signals from the Signal Processing Assembly of the Electronics Subsystem connects via electrical connector on each antenna subassembly.

Resolver drive signals from the Signal Processing Assembly of the Electronics Subsystem connect via electrical connector on each antenna subassembly.

Outputs

Microwave output signals are provided from the multiplexers (or diplexer) to the corresponding Receiver subsystem channel via waveguide connection.

Motor hall effect sensors connect via electrical connectors to the Signal Processing Assembly of the Electronics Subsystem.

Resolver position analog signals connect via electrical connectors to the Signal Processing Assembly of the Electronics Subsystem.

Temperature sensors in the warm calibration load and on other components connect via electrical connectors to the Signal Processing Assembly of the Electronics Subsystem.

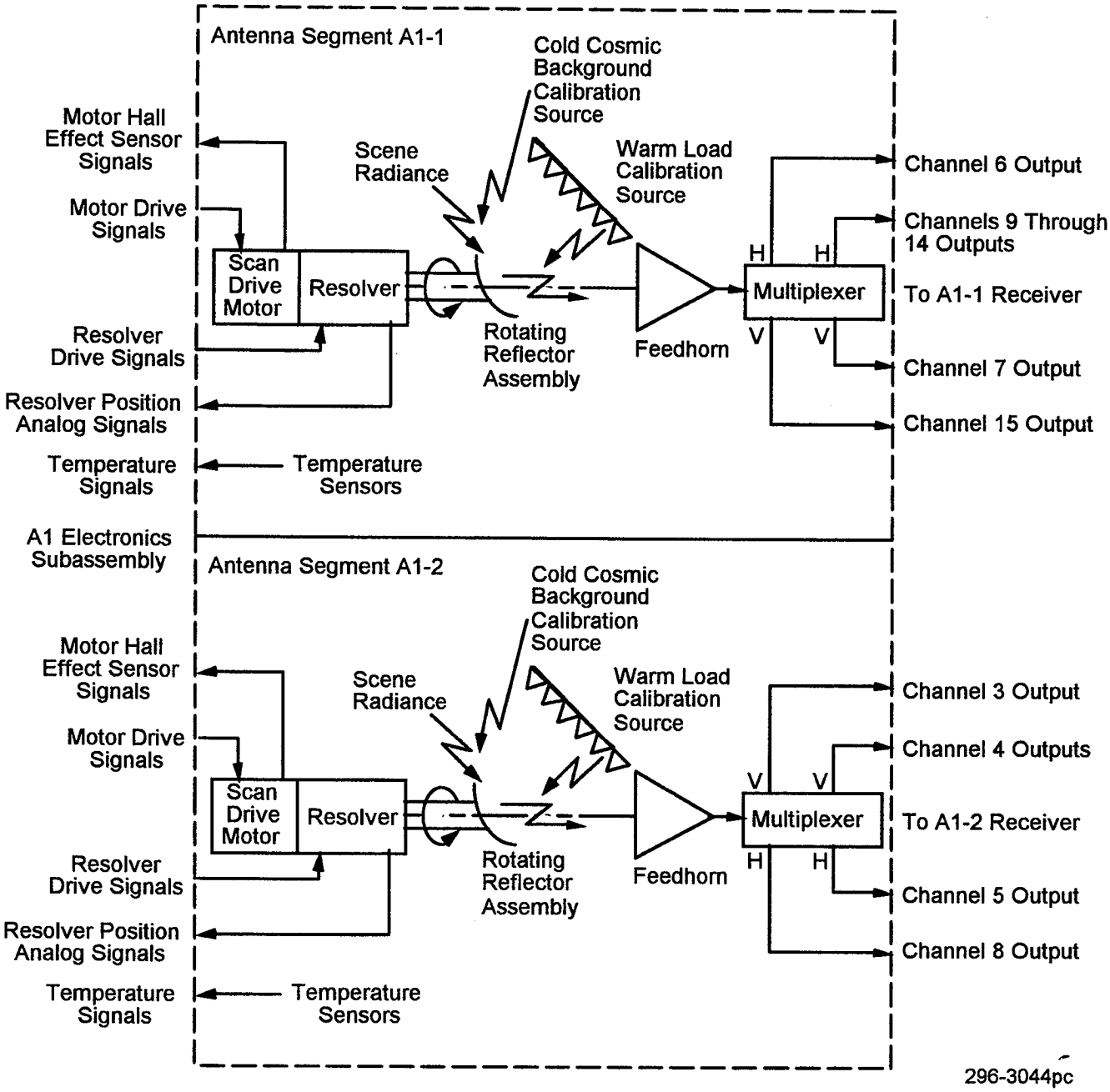


Figure 7 AMSU-A1 Antenna Functional Block Diagram

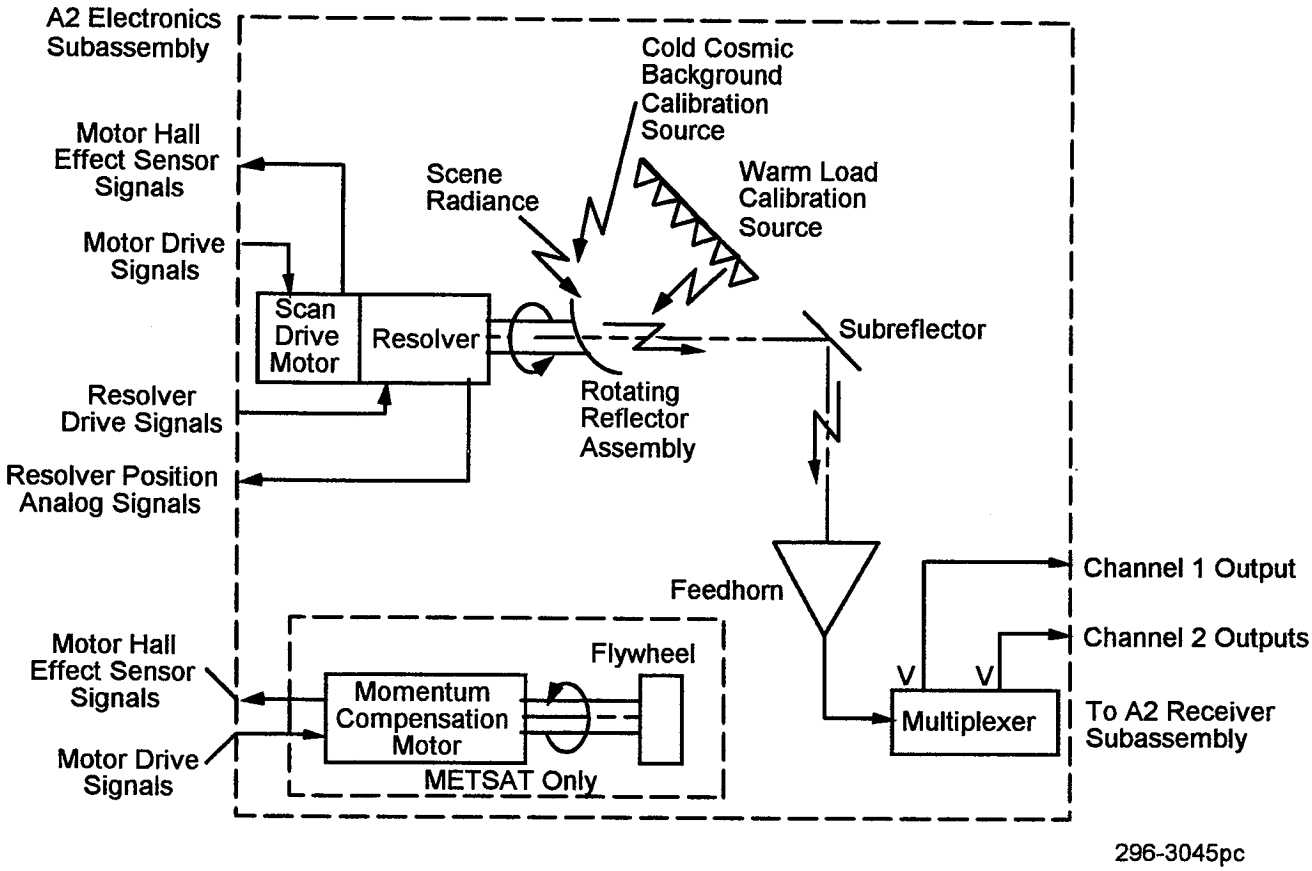


Figure 8 AMSU-2 Antenna Functional Block Diagram

7.2 *AMSU-A Functional Description for the EOS Instrument*

7.2.1 *Antenna Functions*

The cross-track scanning of the Earth scene is accomplished in a stepped fashion with a dwell of 165 msec for AMSU-A1 and 158 msec for AMSU-A2 at each of the 30 Earth-viewing angles, and a dwell of 330-ms for AMSU-A1 and 316-ms for AMSU-A2 at the cold and warm calibration angles. Scanning of the antenna is accomplished in a rapid-step fashion. A complete rotation of the antenna is accomplished in 8 seconds. During each rotation of the AMSU-A antennas, the AMSU-A modules are calibrated with a cold reference by a view of the 3 K cosmic background radiation and a warm reference by a view of a target at a nominal 300 K temperature.

The antenna assembly is rotated using brushless DC torque motors with precision duplex ball bearing sets. The motors use brushless resolvers for position indication.

Each antenna subassembly is configured with a shrouded parabolic reflector assembly that feeds a wideband corrugated conical horn to provide a symmetrical beam and high beam efficiency. A closed path calibration system provides a completely shrouded path to the calibration target that eliminates extraneous signals.

7.2.2 *Receiver Functions*

Within the electronics subassembly are the radiometer receiver and the signal processor. To maximize the system temperature sensitivity, each receiver is a total power, superheterodyne configuration that uses either a dielectric resonator oscillator (DRO), phase-locked oscillator (PLO), or Gunn diode oscillator (GDO).

The mixers, in conjunction with the local oscillators, down convert the incoming radio frequencies (RF) at the antenna to intermediate frequencies (IF). Predetection gain and passband characteristics are achieved by IF amplifiers and the bandpass filters. Channel center frequency stabilization is provided by highly stable LO. A PLO which is referenced to the harmonic of a crystal oscillator provides the frequency stability required in Channels 9 through 14.

The gain of the IF amplifiers is selected to provide an optimum power level for the square-law detectors. Symmetric passbands for Channels 11 through 14 are established in the MHz frequency region to generate the identical RF signal spectra. The dual-summed surface acoustic wave (SAW) filters provide a $\sqrt{2}$ sensitivity improvement in these channels. The SAW filters provide sharp skirts and required center frequency stability. The square-law detectors convert receiver output power to a dc current equivalent of brightness temperature.

7.2.3 *Data Processing - Multiplexing Functions*

From square-law detector outputs, processor subsystems provide radiometric temperature, thermometric temperature, and housekeeping data to the spacecraft system; the subsystems also provide command processing and control timing for all periodic functions of the instruments.

DC video amplifiers amplify low-level detector signals to levels sufficient for subsequent processing. Video amplifiers are contained in shielded enclosures along with the square-law detectors. Following video amplification, an offset voltage is added to obtain placement of the system transfer characteristic at the desired position within the range of the A/D converter. The integrate-and-dump (I&D) filters integrate video signals during each beam dwell period (165 ms for A1, 158 ms for A2), hold the integrated levels during digitization, and dump to zero prior to the next beam dwell period. Brightness temperature isolation between scene stations is provided by resetting the filters.

A 16-bit A/D converter digitizes all scene, calibration, and instrument thermometric temperatures for eventual serial readout to the spacecraft. Inputs to the A/D converter are selected by the analog multiplexers, controlled by a microcomputer. During scene and calibration periods, multiplexers switch to I&D filter outputs. Between calibration periods, the multiplexer switches to platinum resistance thermister (PRT) voltages.

The A/D converter digitizes I&D filter outputs during hold intervals and PRT voltages between calibration periods. The microcomputer sequentially transfers data from the A/D converter to the spacecraft.

The A/D converter range accommodates long-term channel gain variations and the resolution provides digitization noise components within system ΔT budgets.

7.2.4 *Temperature Monitoring*

Thermometric temperatures of microwave components and other critical AMSU-A items are provided by precision PRT sensors and calibrated conditioning circuits. Conditioned PRT voltages are digitized and read out to the spacecraft along with radiometric temperature data.

7.2.5 *Central Processing Unit (CPU) and Control (Microcomputer)*

All processing, clock, command, and telemetry functions of the AMSU-A are controlled within the signal processing section of the electronic subassembly by a space-qualified, radiation-hardened microprocessor.

The digital processor consists of microprocessor-based circuits for data control, frame timing, and reflector interface control.

By means of address and data busses, the microprocessor controls all data operations within the radiometer processing subsystem. During the scene segment of each reflector scan, digitized scene radiometric temperature data of Channels 3 through 15 in the A1 module, Channels 1 and 2 in the A2 module, and antenna position data are processed by the microcomputer. The microcomputer consists of five circuit card assemblies (CCA): (1) CPU, (2) memory, (3) scan control, (4) timing control generation (TCG), (5) MIL-STD-1553 interface. A description of these CCA is provided in Table III. In processing instrument data, the CPU, through the TCG, commands the analog MUX. This converts parallel analog data into a serial stream for conversion to digital format by the A/D converter. The digital data are sent back to the TCG which transfers them to the microprocessor data bus. The CPU routes the data to the MIL-STD-1553 interface where two successive frames are stored in first in, first out (FIFO) memory and random access memory (RAM). The spacecraft can extract the data from the RAM asynchronously.

To control the antenna, the CPU gets position data from the memory and routes a position command through the scan control latch in the motor circuit(s). A strobe signal from the TCG transfers the position data to a digital comparator where digitized resolver position data subtracted from it. The difference signal (the position error) is converted into analog form and drives the motor to the new position.

The microprocessor and other complementary metal oxide semiconductor (CMOS) logic except for the MIL-STD-1553 interface microcircuit operates from +5 Vdc to minimize power consumption, and has response sufficient to complete all data control requirements with considerable time margin. The MIL-STD-1553 microcircuit uses both +5 Vdc and -15 Vdc.

7.2.6 *Clock and Command*

The analog multiplexer input selection, integrate, hold, and dump intervals, and digitization and reflector stepping functions are controlled by the microcomputer. The CPU operates from an internally generated clock pulse of 1.248 MHz. The DC/DC converter is synchronized to this frequency.

An 8-second pulse provided by the spacecraft via the MIL-STD-1553 bus initiates each scan cycle. Circuits on the MIL-STD-1553 interface CCA extract these data and supply them to the CPU.

Since Channels 9 through 14 of the AMSU-A1 unit use a phase locked oscillator (PLO) with a redundancy; a command is available to select the redundancy to be used. Two scanner power commands independently control power to the AMSU-A1 scan subsystems. The AMSU-A2 scan subsystem also has a commanded power input.

The precise position of the reflector during cold calibration (i.e. when it is staring into cold space) is also controllable. Four discrete calibration positions are available by setting two command bits high or low.

7.2.7 *Test Points and Telemetry*

The EOS/AMSU-A instrument provides test points and analog telemetry outputs. The analog multiplexer inputs and the A/D converter analog input are resistor-buffered and brought out to a test connector to aid in troubleshooting. Analog telemetry (engineering data) provides analogs of supply voltages, bus currents, and temperatures. Digital engineering data include instrument mode, scan power and PLO power relay status, PLO lock status, and A/D converter latchup indicator. These data are multiplexed once per scan, and output on the MIL-STD-1553 interface.

7.2.8 *Temperature Monitoring*

Twelve resistor temperature sensor networks on AMSU-A1, and six on AMSU-A2, input to the spacecraft the passive analog telemetry to provide temperature data independent of instrument operational status. Power bus redundancy monitor outputs are also provided to the spacecraft passive analog interface.

7.2.9 *Input Filter, DC/DC Converter, and Relay Control*

From the redundant +28-volt spacecraft quiet power bus, AMSU-A power systems provide regulated voltages to receiver and radiometer processor subsystems. Redundant reflector scanning motors operate from the +28-volt noisy power bus.

Power on/off control is not provided by the AMSU-A modules; switching between the bus redundancies is automatically performed by relay circuits in the instrument.

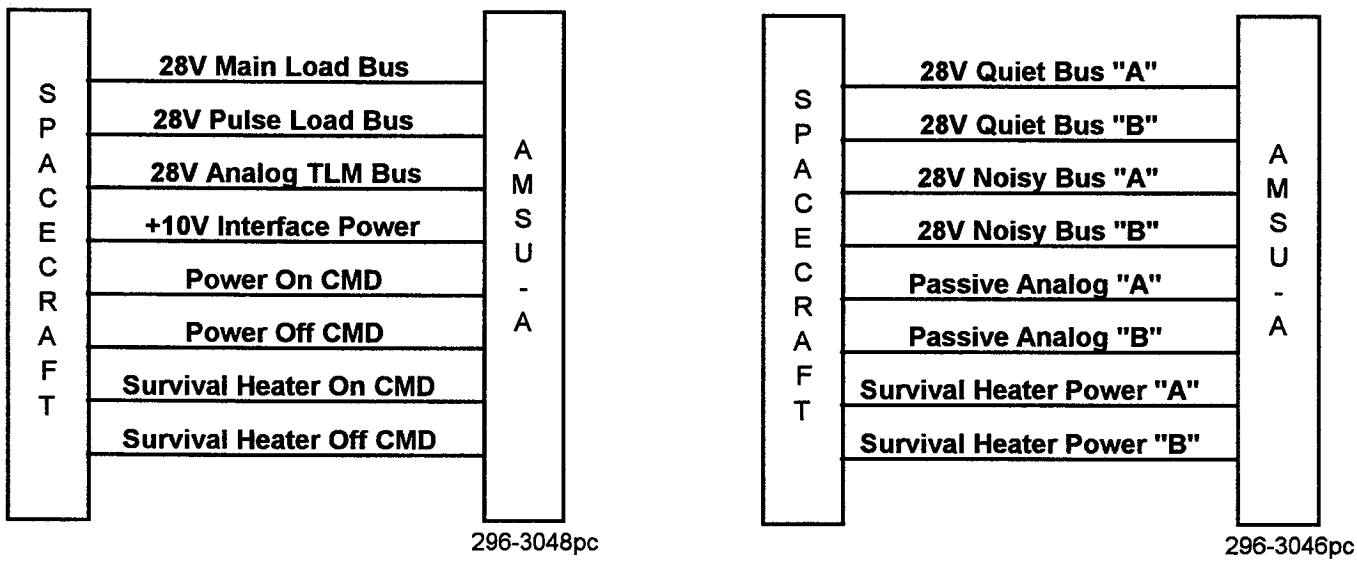
A single DC/DC converter in each unit provides receiver and radiometer processor voltages isolated from the +28-volt bus. The DC/DC converter is synchronized to the 1.248 MHz CPU clock. The DC/DC converter provides regulated output of +15 volts, -15 volts, +8 volts, +5 volts, and +10 volts. The mixer/IF amplifiers share a common +10-volt output. A common +8-volt output supplies receiver IF amplifier power. ±15 V outputs supply power to video amplifiers and other analog circuitry of the radiometer processor. The +5-volt output is utilized for the data processing functions of the radiometer processor subsystem. Additional isolated ±15 V and +5V supplies are provided for the scan drive subsystem. The PLO on AMSU-A1 also has independent ± 15 V supplies.

In the absence of the clock signal, the converter will run asynchronously. Input diodes protect the converter from polarity reversal damage. DC/DC converter output voltage regulation is maintained for main power bus input voltages of +24 to +35 volts. Above +40 volts, the converter will shut down.

Scan motors operate from the noisy +28-volt bus. Power to the scan motors is controlled by means of latching relays controlled by the scanner power command.

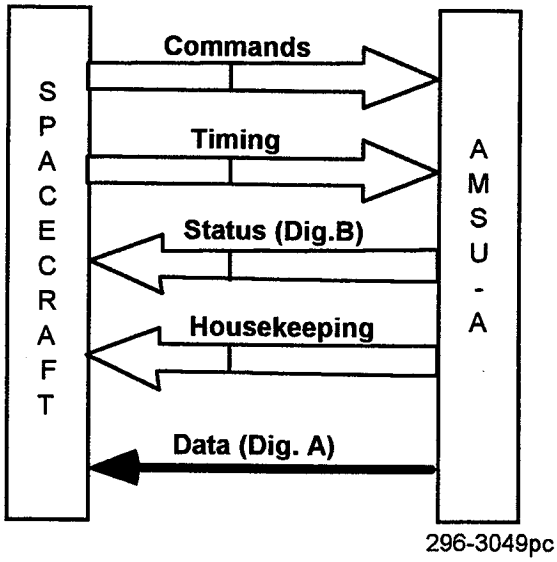
7.3 *Description of METSAT/EOS Unique Functions/Hardware*

The major differences between METSAT and EOS AMSU-A instruments are the Power Interfaces and Signal Interfaces with the spacecraft. As shown in Figure 9 the EOS power interface has been improved to take advantage of the spacecraft "quiet" 28 volt supply bus. The "quiet" bus reduces instrument internal noise generation and improved producibility and "safe-to-mate" capability. To implement the power interface improvement required a change in the METSAT power relay and housekeeping circuit card assembly, thus creating a power control and monitoring circuit card assembly for the EOS instrument. The new EOS power control and monitoring circuit card assembly has automatic input power sense and select functions. As shown in Figure 10, the EOS signal interface compared to METSAT has been changed to take advantage of the spacecraft MIL-STD-1553 data bus interface and elimination of the external 1.248 MHz clock interface. This change deleted the METSAT spacecraft interface circuit card assemblies from the EOS design and replaced them with a MIL-STD-1553 interface circuit card assembly.

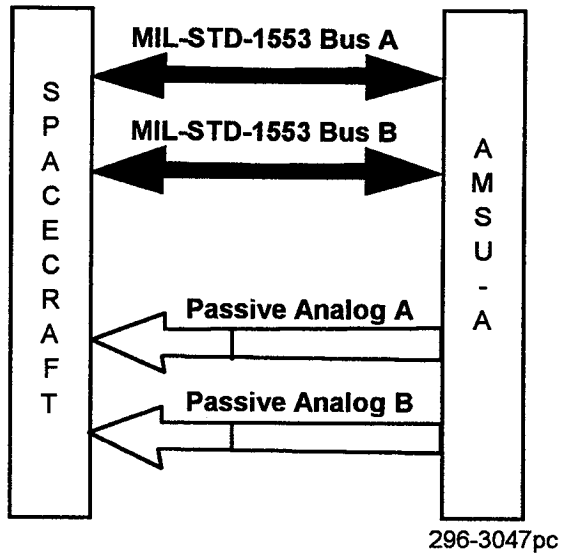


Power Interface for METSAT **Power Interface for EOS**

Figure 9 Power Interface Differences



Signal Interface for METSAT



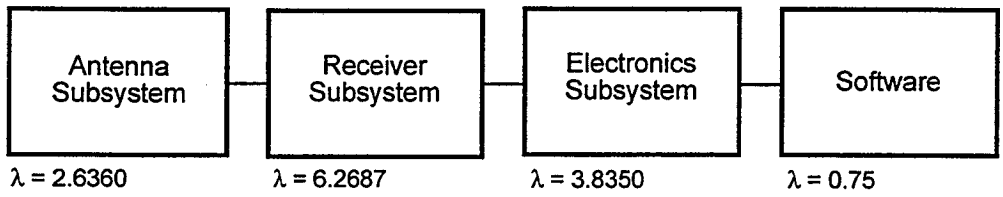
Signal Interface for EOS

Figure 10 Signal Interface Differences

7.4 *Reliability Block Diagram*

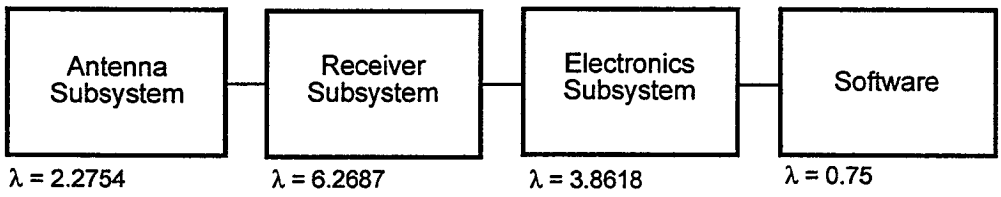
The following figures show the reliability block diagram for the METSAT and EOS AMSU-A instruments. The block diagram is partitioned functionally as the A1 Module (Figure 10) and the A2 Module (Figure 11). Next, the block diagram is partitioned into the Antenna Subsystem, Receiver Subsystem, and Electronics Subsystem*. A functional description of each partition is provided in Section 6.0 herein, and this description further points out the functional differences between the METSAT and EOS instruments.

METSAT Top View Reliability Block Diagram



METSAT λ = 13.4897

EOS Top View Reliability Block Diagram



EOS λ = 13.1559

396-3025M

Figure 11 Top View, AMSU-A Subsystems, Reliability Block Diagram

* Functional differences between METSAT and EOS are located in the Electronic Subsystem and a separate block diagram is provided for the METSAT and EOS Electronic Subsystems. In the Antenna Subsystem there is a compensation assembly shown on the METSAT/EOS block diagram and it is identified as METSAT only.

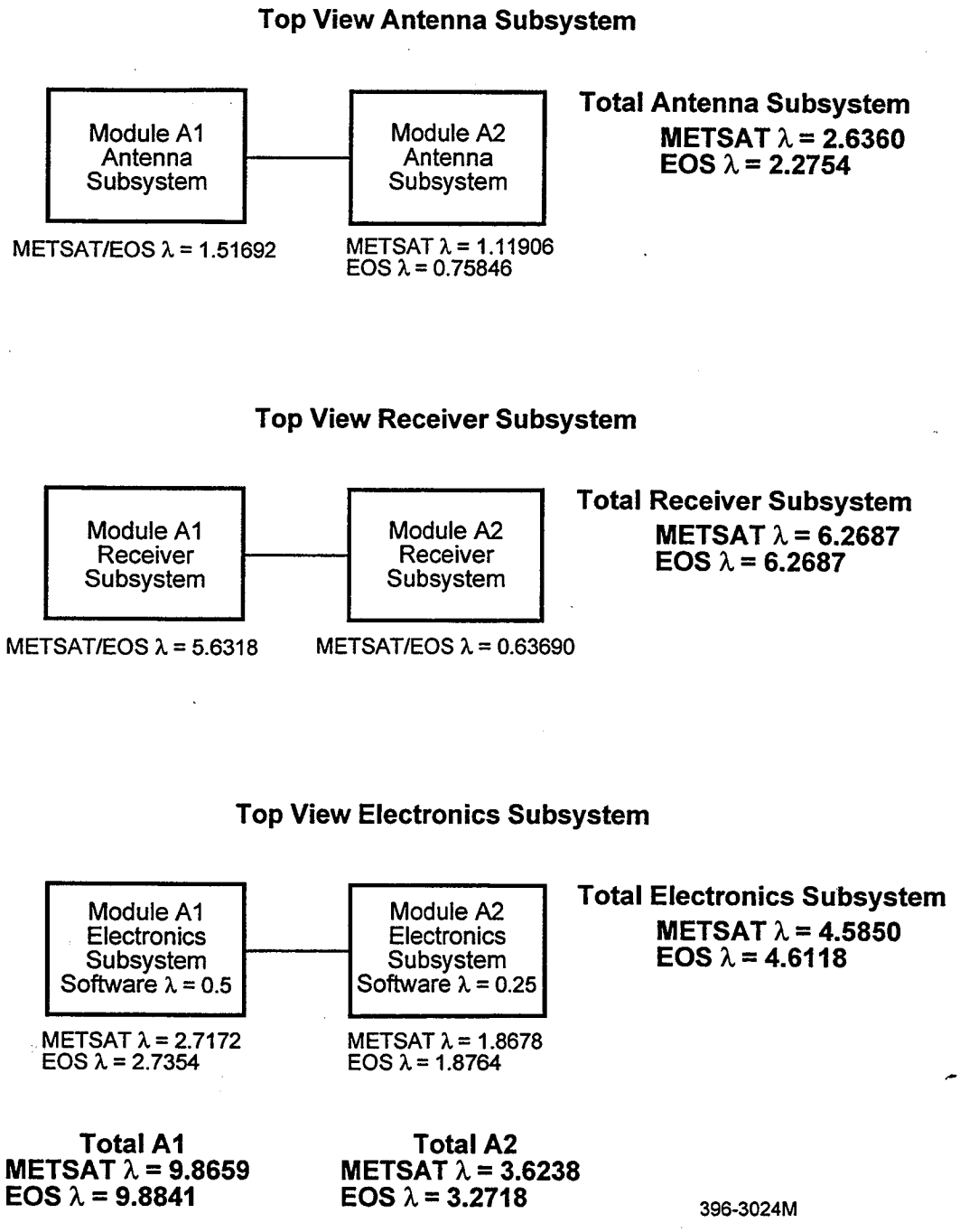


Figure 12 Top View, AMSU-A Module A1 and A2 Reliability Block Diagram

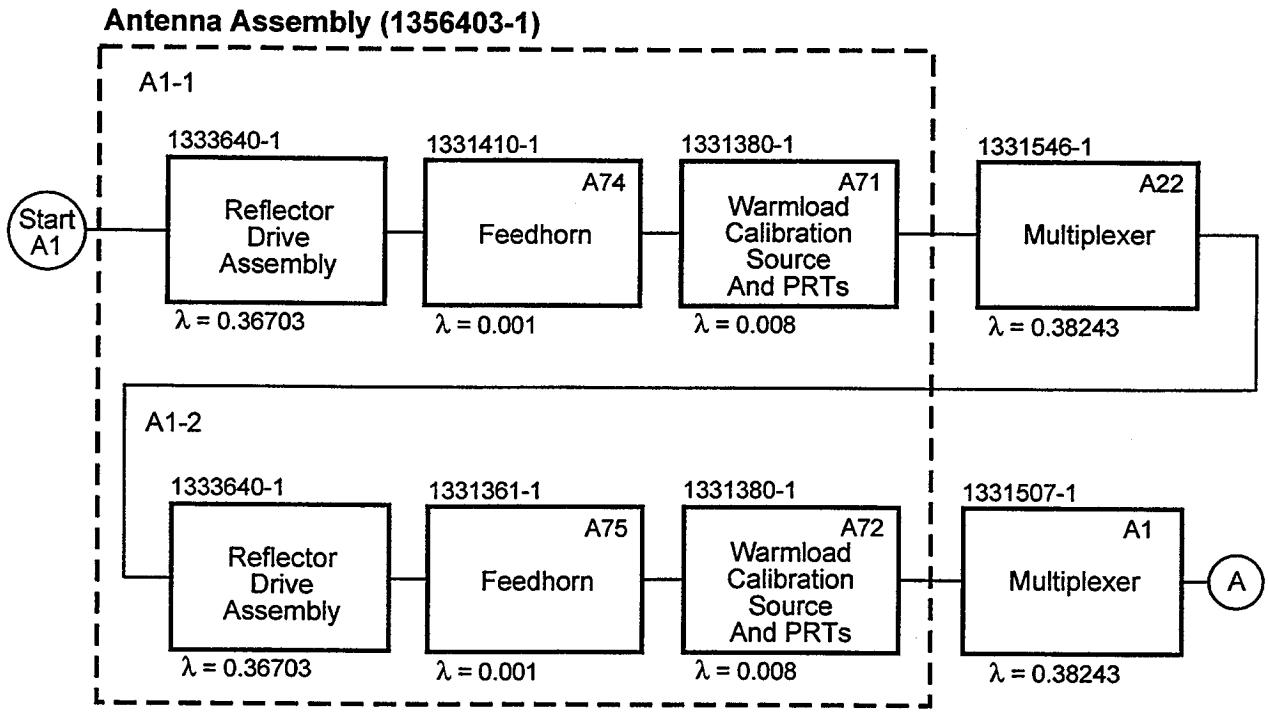


Figure 13 Module A1, Antenna Subsystem, METSAT/EOS Reliability Block Diagram

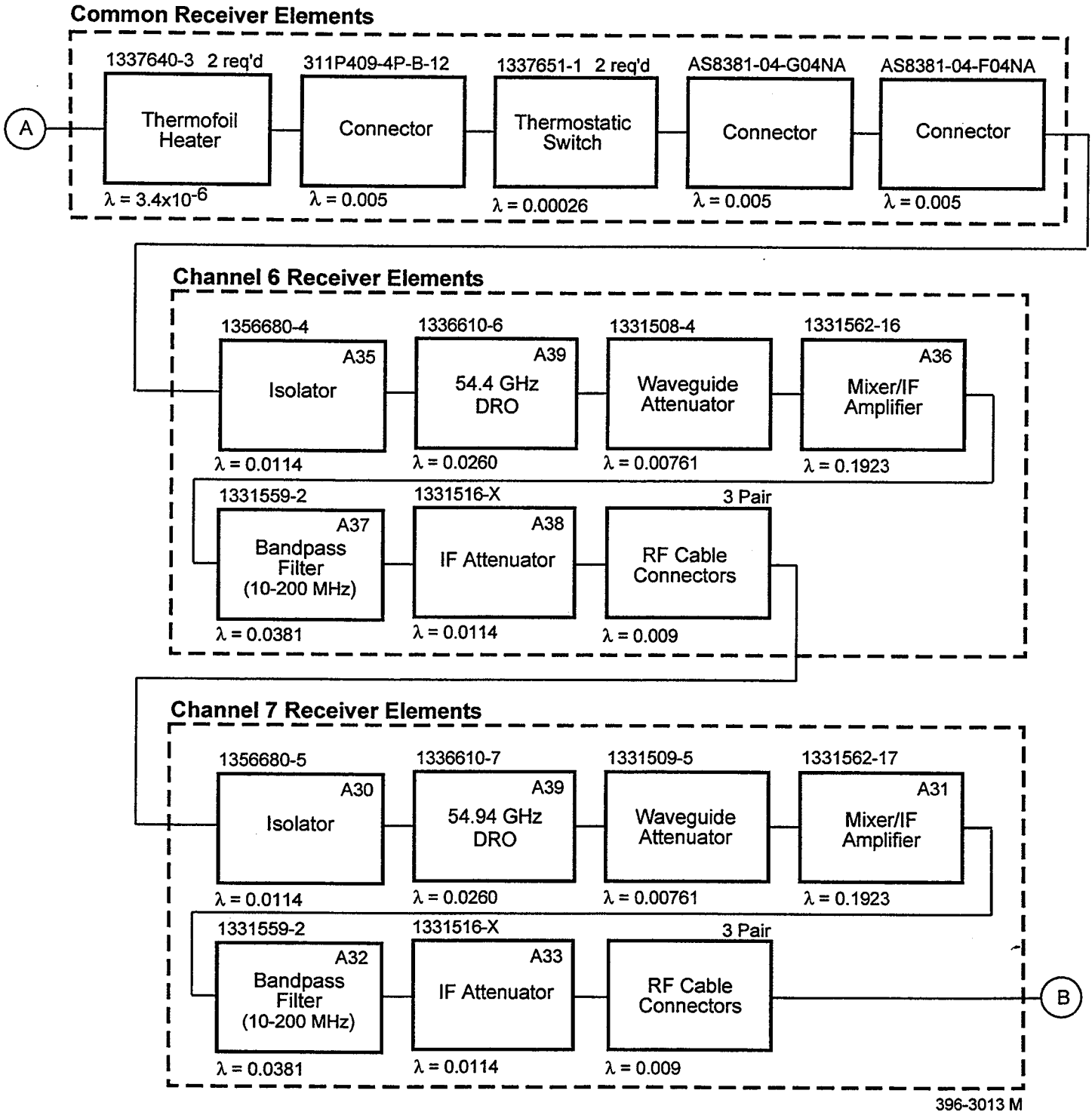


Figure 14 Module A1, Receiver Subsystem, METSAT/EOS Reliability Block Diagram

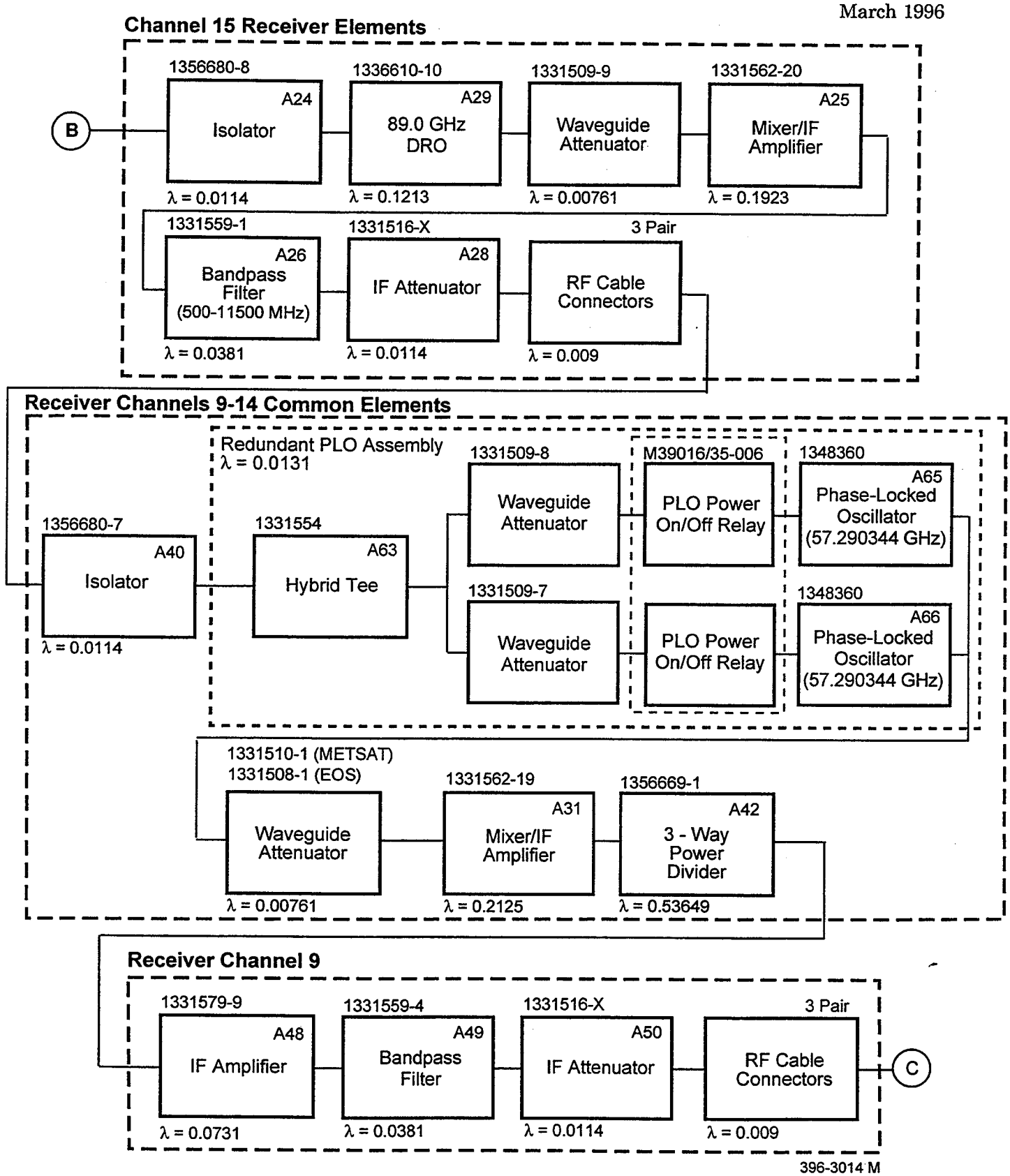


Figure 14 Module A1, Receiver Subsystem, METSAT/EOS Reliability Block Diagram (Continued)

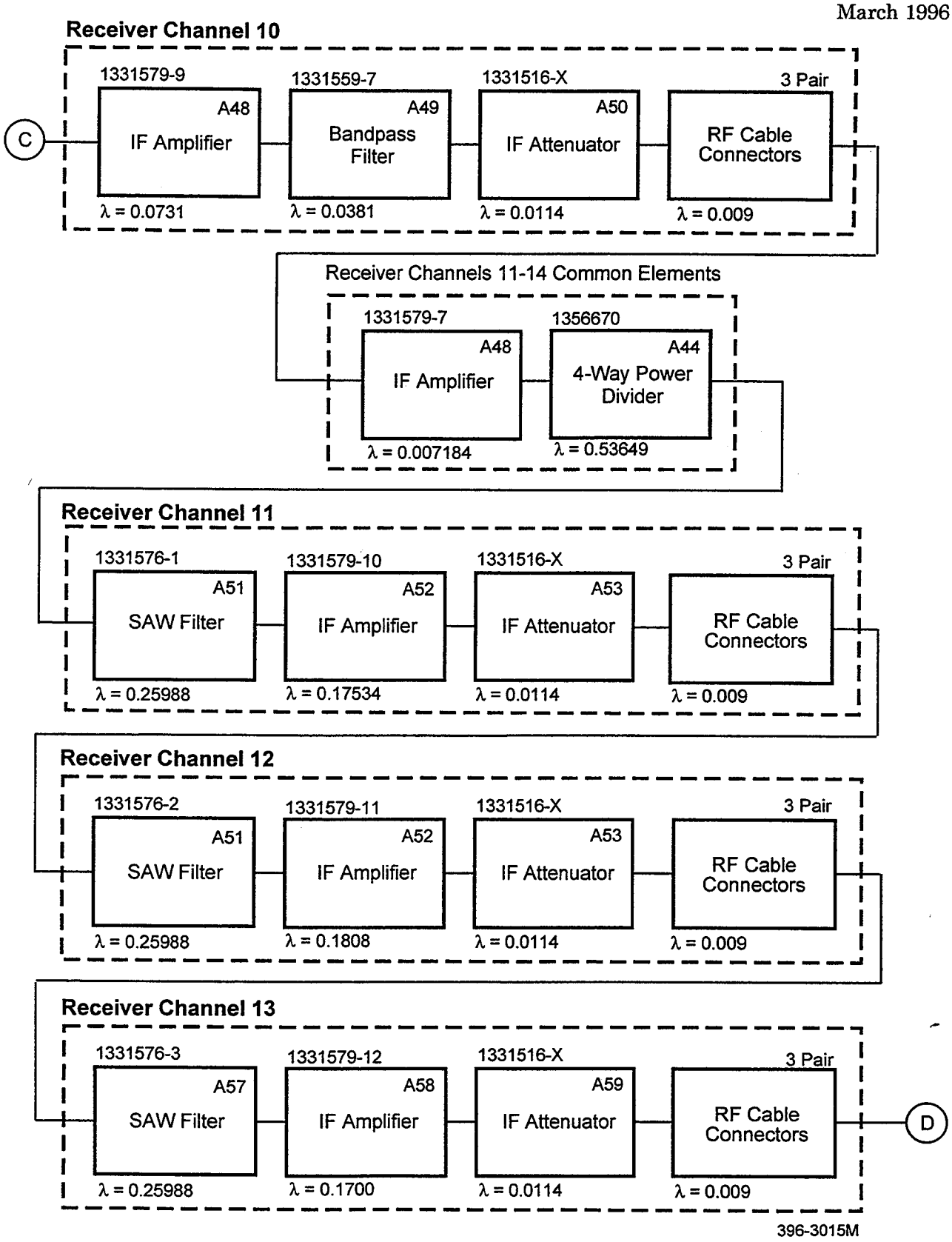


Figure 14 Module A1, Receiver Subsystem, METSAT/EOS Reliability Block Diagram (Continued)

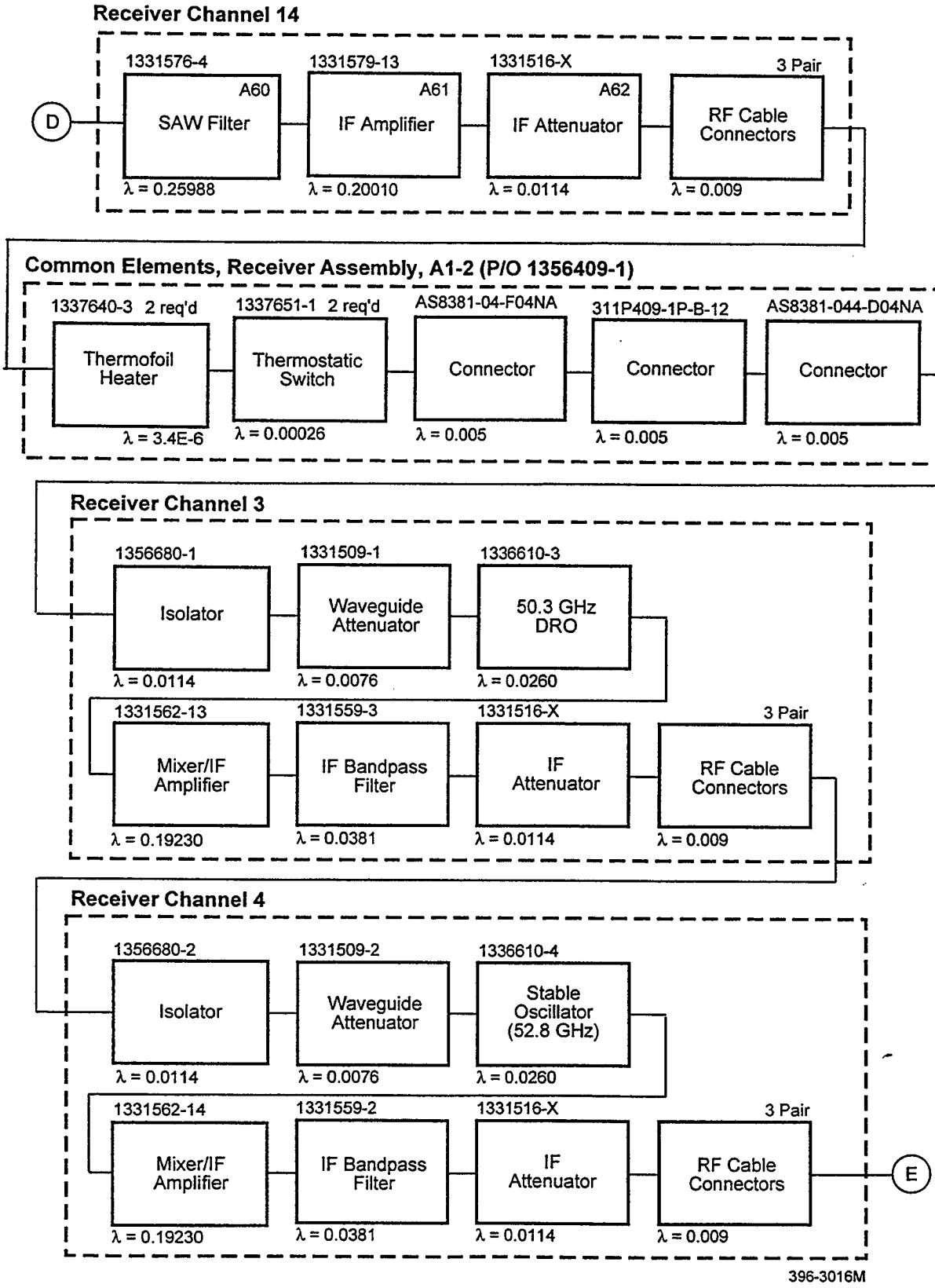


Figure 14 Module A1, Receiver Subsystem, METSAT/EOS Reliability Block Diagram (Continued)

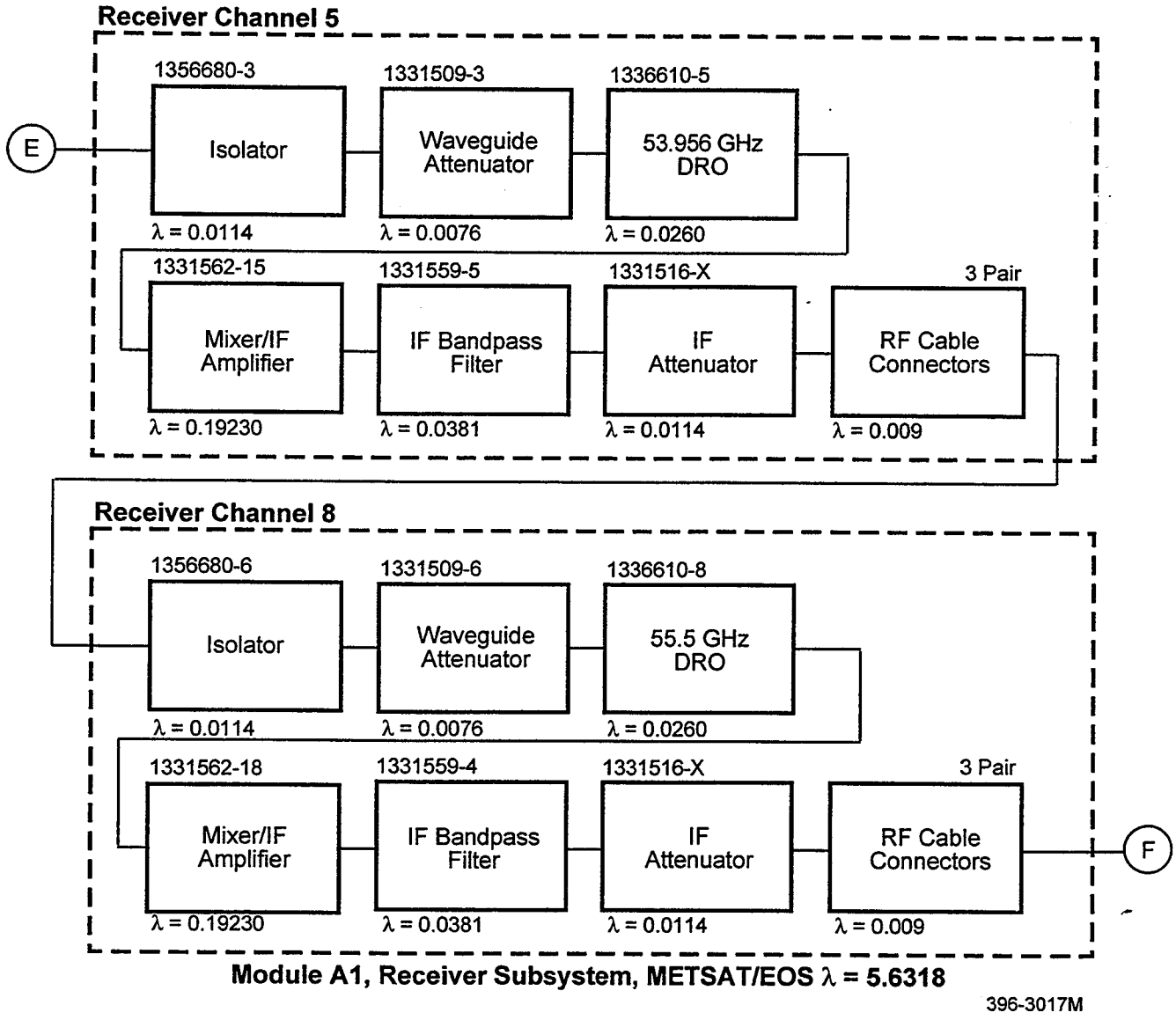


Figure 14 Module A1, Receiver Subsystem, METSAT/EOS Reliability Block Diagram (Continued)

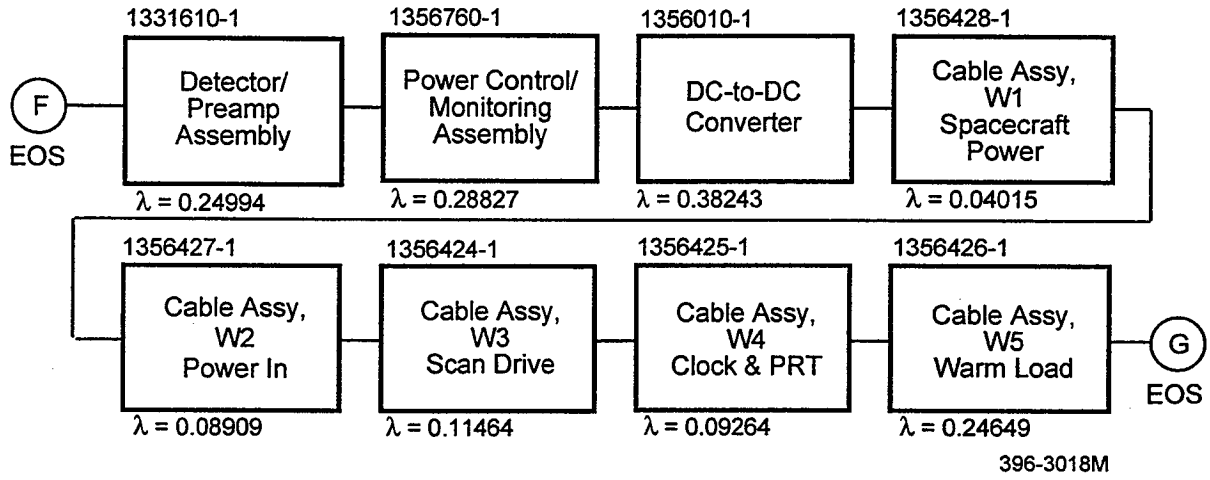
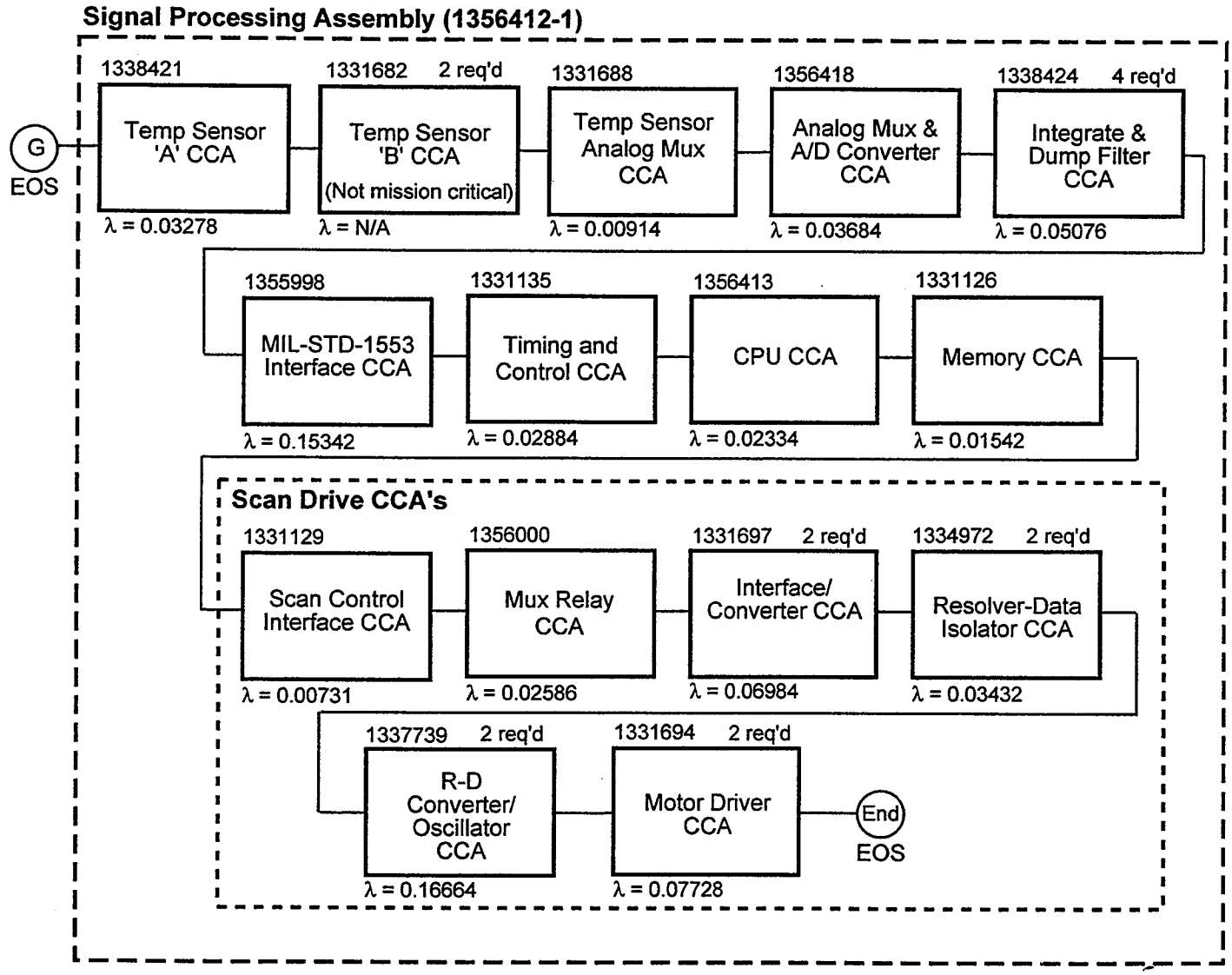


Figure 15 Module A1, Electronics Subsystem, EOS Reliability Block Diagram



Module A1, Electronics Subsystem, EOS λ = 2.2354

396-3019M

Figure 15 Module A1, Electronics Subsystem, EOS Reliability Block Diagram (Continued)

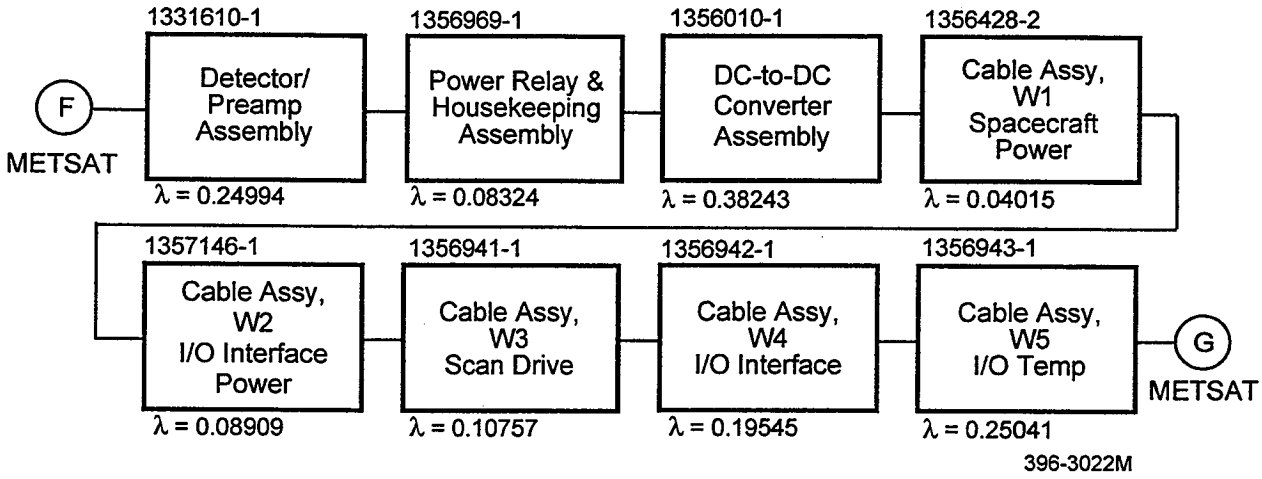


Figure 16 Module A1, Electronics Subsystem, METSAT Reliability Block Diagram

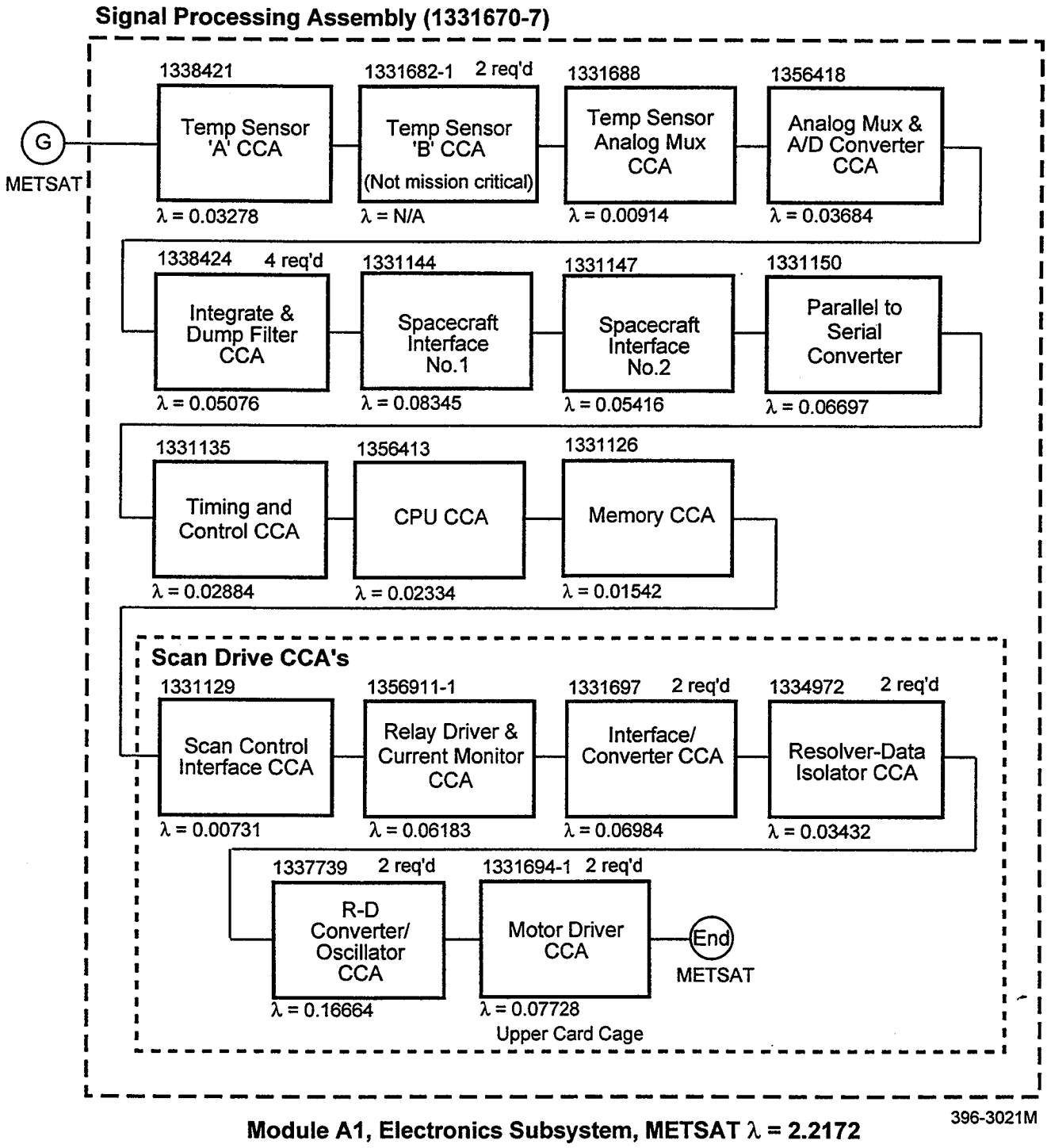


Figure 16 Module A1, Electronics Subsystem, METSAT Reliability Block Diagram (Continued)

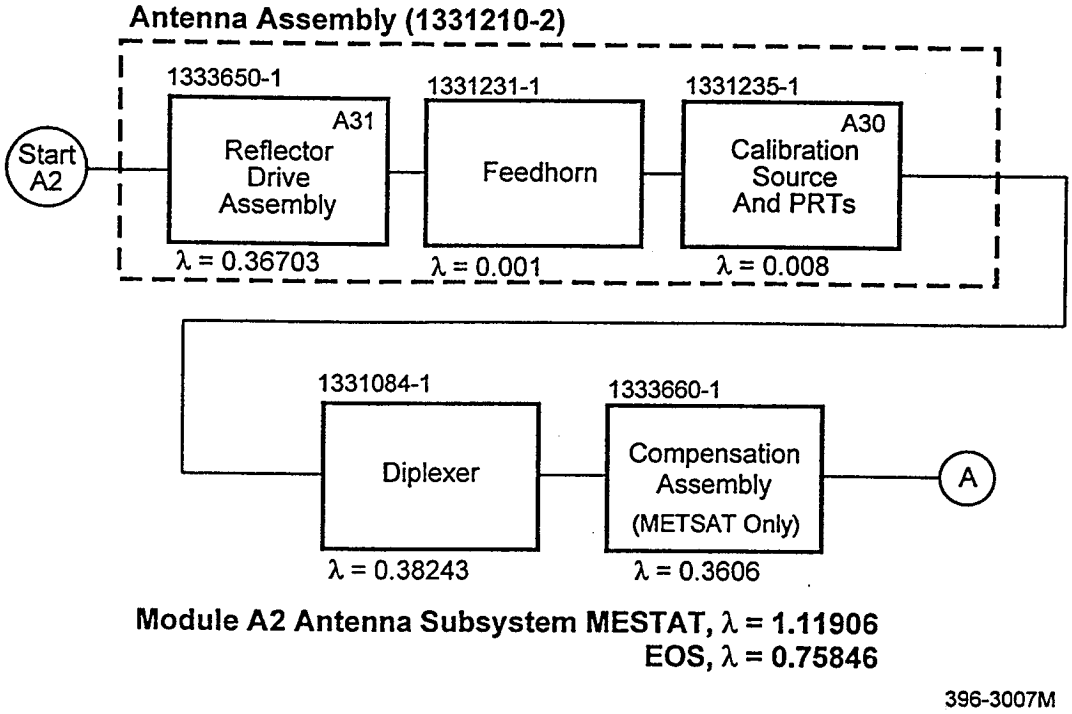


Figure 17 Module A2, Antenna Subsystem, METSAT/EOS Reliaiblity Block Diagram

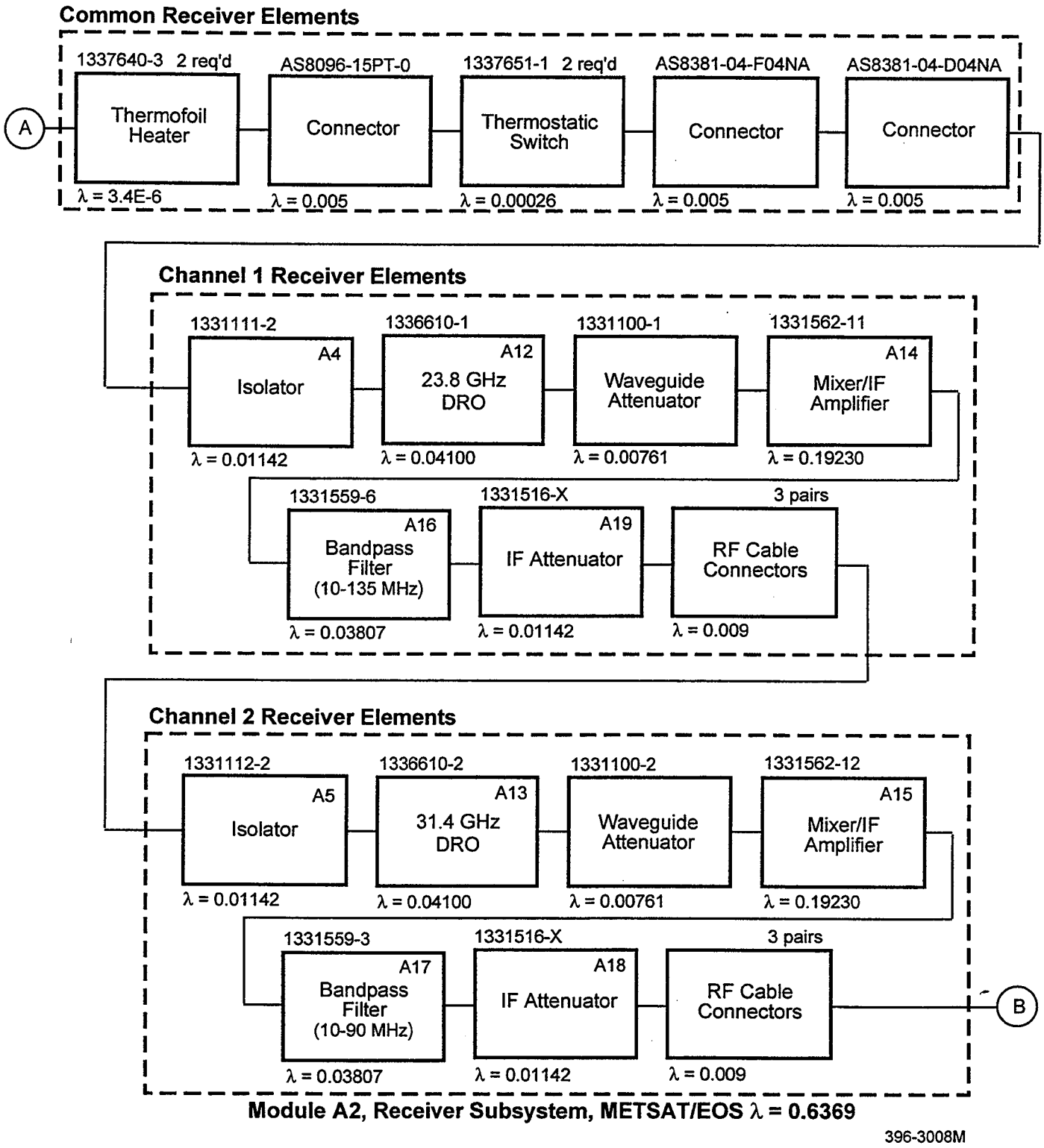


Figure 18 Module A2, Receiver Subsystem, METSAT/EOS Reliability Block Diagram

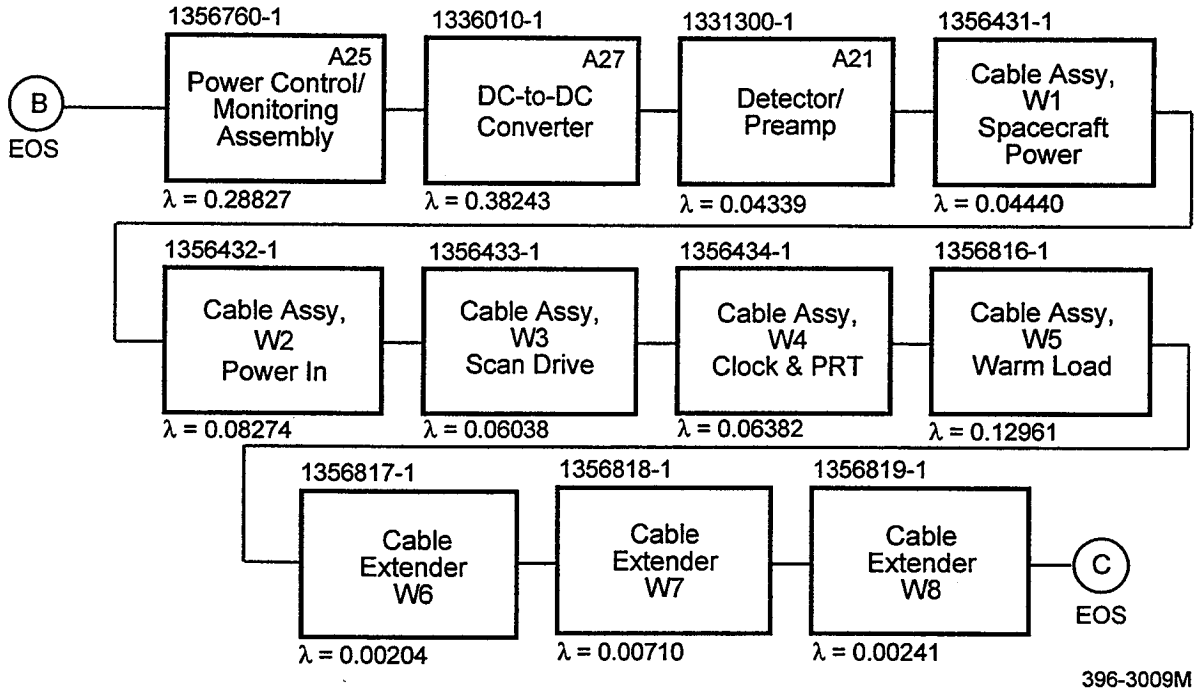


Figure 19 Module A2, Electronics Subsystem, EOS Reliability Block Diagram

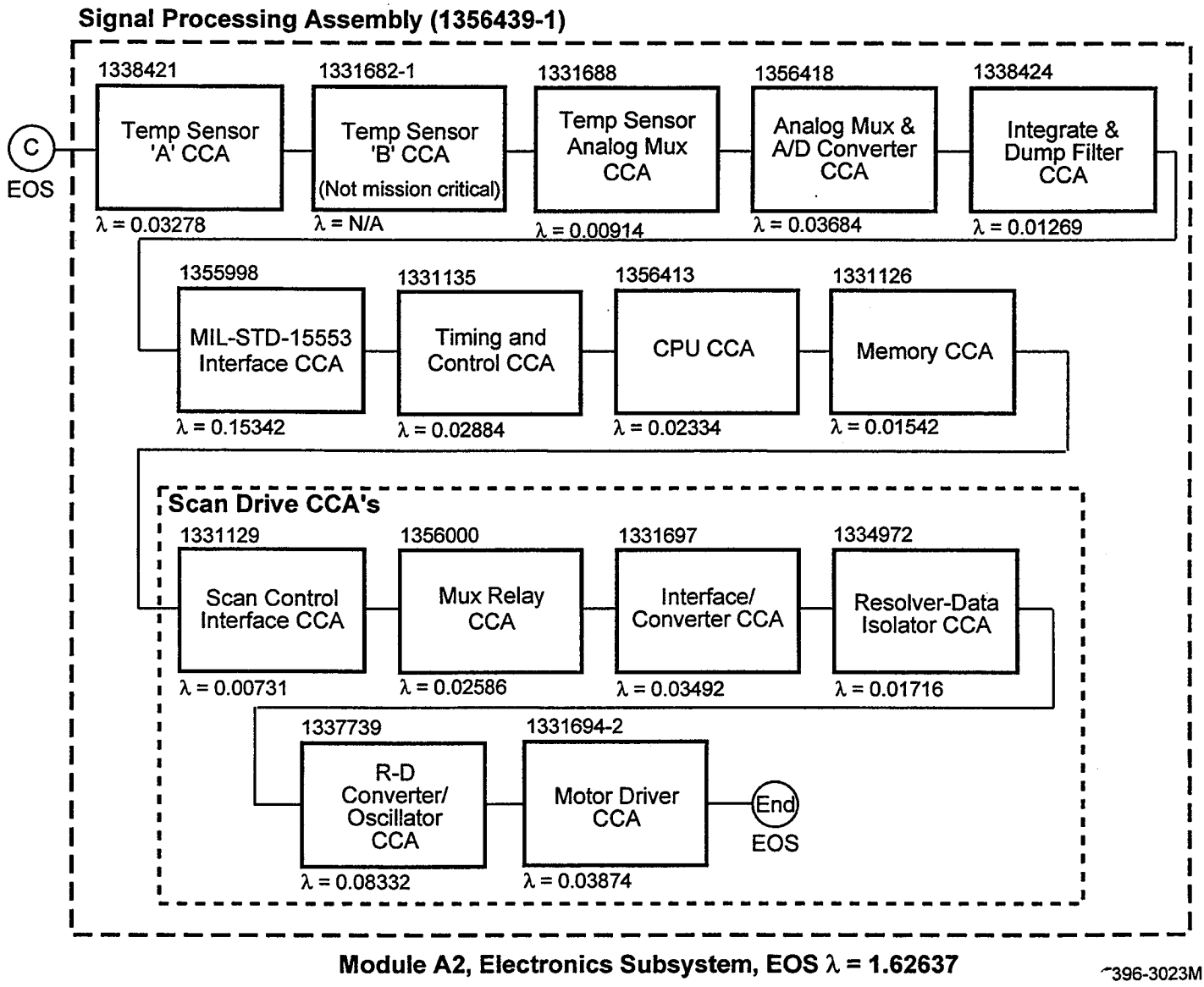


Figure 19 Module A2, Electronics Subsystem, EOS Reliability Block Diagram (Continued)

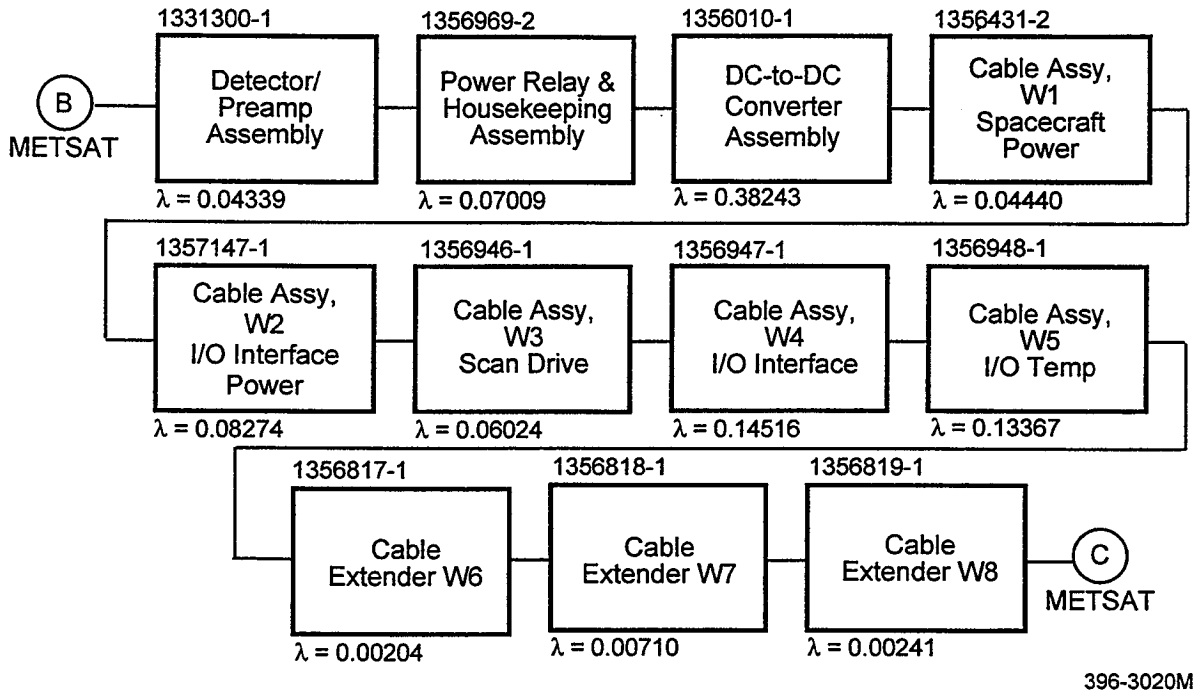


Figure 20 Module A2, Electronics Subsystem, METSAT Reliability Block Diagram

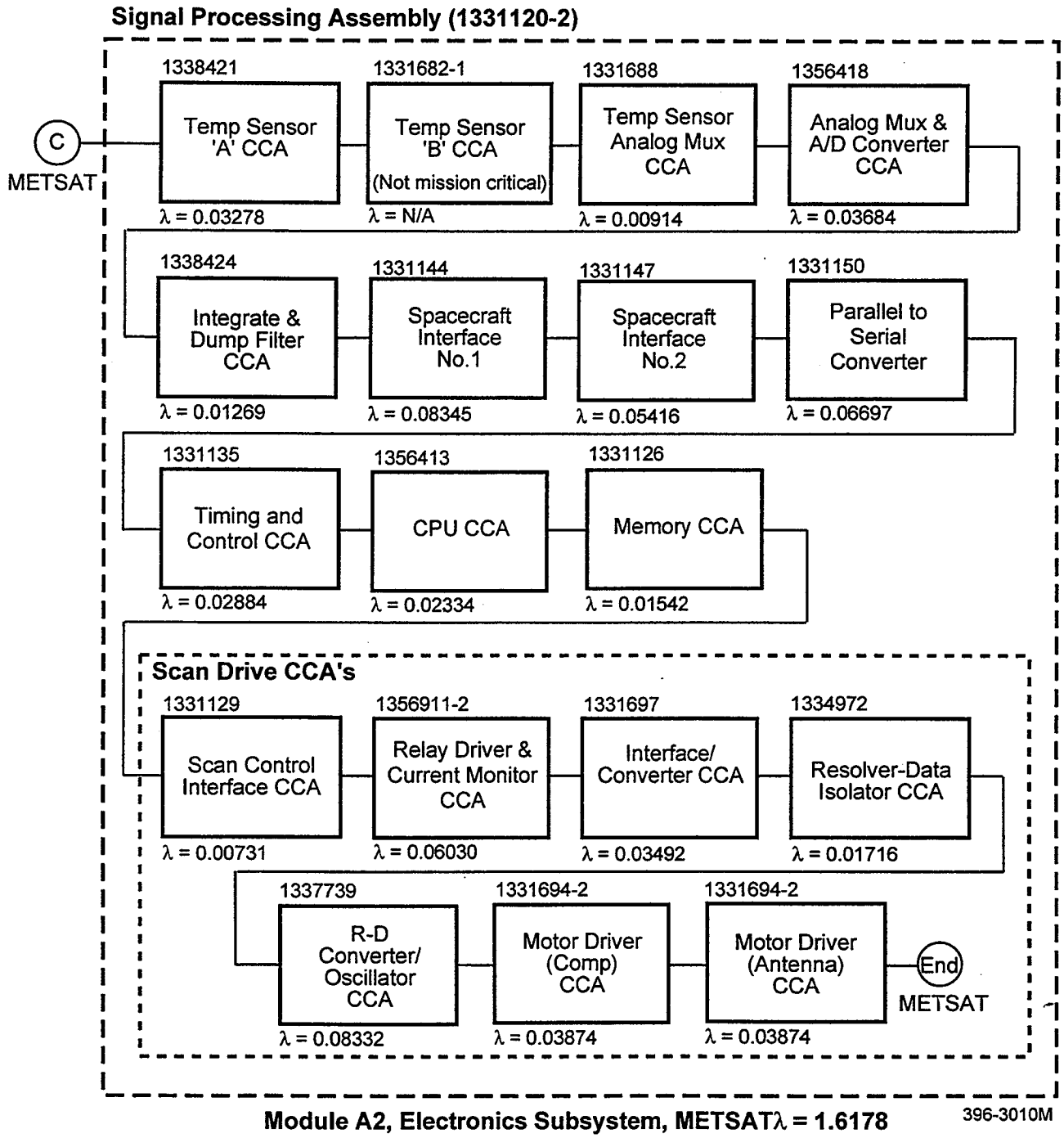


Figure 20 Module A2, Electronics Subsystem, METSAT Reliability Block Diagram (Continued)

APPENDIX A

FMEA WORKSHEETS FOR EOS AND METSAT AMSU-A INSTRUMENTS

NOTE: "System" block on worksheet indicates if worksheet applies to EOS only, METSAT only, or EOS/METSAT. (Both EOS and METSAT have the same function hardware.

APPENDIX A

Table of Contents

Section A1

Module A1 to Spacecraft Interface
FMEA Worksheets

NOTE: "System" block on worksheet indicates if worksheet applies to EOS only, METSAT only, or EOS/METSAT. (Both EOS and METSAT have the same function hardware.

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level A1 - S/C Interface
Reference Drawing See GIRD/UIID

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	Mechanical Attachment	Provides direct base mount attachment of the AMSU-A1 module to the spacecraft	MODE Separation of the A1 module from S/C	LAUNCH	Possible damage during launch or staging	Loss of capability to perform mission	None during or after launch	Responsibility of spacecraft contractor	I	Remote
			CAUSE Loosening or fracture of mounting bolts							
	Thermal Interface	Minimize heat flow between the A1 module and the spacecraft	MODE Exceeds the +10°C to +65°C window	MISSION	Degraded sensitivity	Degraded sensitivity	House-keeping output serial data	Minimum reliance on spacecraft for heat sink	III	Occasional

Failure Modes and Effects Analysis

System EOS/ONLY
Indenture Level A1 - S/C Interface
Reference Drawing See GIRD/UIID

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	Electrical Interfaces EOS/AMSU-A1 to space-craft									
	Input Power	Provide +28 VDC main power, and +28V analog temperature telemetry	MODE Short or overload on incom-ing +28V primary power (quiet bus)							
			CAUSE 1. Cable short	MISSION	Chance of loss of data on all 13 channels	Significant de-gradation of mission only if both redundan-cies fail	Analog house-keeping telemetry loss of data	Design inspec-tion and test requirements are imposed	I	Remote*
			2. Faulty Filter Pin (1331712)	MISSION	Same as above	Same as above	Same as above	100% inspection and test of connector filter pins	I	Remote
			3. Bus selection circuit shorted to return (1356002)	MISSION	Same as above	Same as above	Same as above	Design inspection and test requirements are imposed	I	Extremely Unlikely
			4. DC/DC converter shorted to return (1356010)	MISSION	Loss of data on all 13 channels	Significant degrada-tion of mission	Same as above	Design inspection and test requirements are imposed	I	Extremely Unlikely

* For causes 1, 2, and 3, short at interface would result in automatic switching to redundant bus.

Failure Modes and Effects Analysis

System METSAT ONLY
Indenture Level A1 - S/C Interface
Reference Drawing See GIRD/UIID

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	Electrical Interfaces EOS/AMSU-A1 to space-craft									
	a. Input Power	Provide +28 VDC main power, +28V pulse load power, and +28V analog temperature telemetry	MODE Short or overload on incom-ing +28V primary power							
			CAUSE 1. Cable short	MISSION	Loss of data on all 13 channels.	Significant degrada-tion of mission only if both redundan-cies fail	Analog house-keeping telemetry loss of data	Design inspec-tion and test requirements are imposed	I	Remote
			2. Faulty Filter Pin (1331712)	MISSION	Same as above	Same as above	Same as above	100% inspection and test of connector filter pins	I	Remote
			3. Turn-on Circuit Shorted to return (1331621))	MISSION	Same as above	Same as above	Same as above	Design inspection and test requirements are imposed	I	Extremely Unlikely
			4. DC/DC converter shorted to return (1356010)	MISSION	Same as above	Same as above	Same as above	Design inspection and test requirements are imposed	I	Extremely Unlikely

Failure Modes and Effects Analysis

System METSAT ONLY
Indenture Level A1 - S/C Interface
Reference Drawing See GIRD/UIID

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	b. Clock Input	Provide 1.248 MHZ clock for timing all AMSU-A functions	MODE Short							
			CAUSE 1. Cable short	MISSION	Useless data on all A1 channels	Significant degradation of mission	System continuously looks at one channel	Design inspection and test requirements are imposed	I	Remote
			2. Spacecraft Interface #1 Short (1331144)	MISSION	Same as above	Same as above	Same as above	Same as above	I	Remote
			3. Spacecraft Interface #2 Short (1331147)	MISSION	Same as above	Same as above	Same as above	Same as above	I	Remote
	c. Command Input	Provides +10V interface power and return in addition to 14 level discrete commands for A1	MODE Short on any command signal line							
			CAUSE 1. Failure in Spacecraft Interface #1 (1331144)	MISSION	Inability to properly control operations	Significant degradation of mission	Erratic or no output data	Design inspection and test requirements are imposed	I	Remote
			2. Failure in Spacecraft Interface #2 (1331147)	MISSION	Same as above	Same as above	Same as above	Same as above	II	Remote

Failure Modes and Effects Analysis

System METSAT ONLY
Indenture Level A1 - S/C Interface
Reference Drawing See GIRD/UIID

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	d. TIP Interface	Provides for select pulse (A_1) and shift pulse (C_1) from spacecraft, digital A output major frame sync, and signal return	MODE Short on serial data							
			CAUSE 1. Failure in Space-craft Inter-face #1 (1331144)	MISSION	No serial data out	Loss of mission	No serial data (stuck low)	Hi-Rel Parts and Design, Test and Inspection are imposed	II	Remote
			2. Failure in Space-craft Inter-face #2 (1331147)	MISSION	Same as above	Same as above	Same as above	Same as above	II	Remote
			MODE Open on serial data							
			CAUSE 1. Failure in Space-craft Inter-face #1 (1331144)	MISSION	No serial data out	Same as above	Same as above	HI-Rel Parts and Design, Test and Inspection are imposed	II	Remote
			2. Failure in Space-craft Inter-face #2 (1331147)	MISSION	Same as above	Same as above	Same as above	Same as above	II	Remote

Failure Modes and Effects Analysis

System METSAT ONLY
Indenture Level A1 - S/C Interface
Reference Drawing See GIRD/UIID

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	e. Digital B Output	Provides for monitoring of command and instrument operational status using 13 bi-level outputs	MODE Short on digital B signal							
			CAUSE 1. Failure in Space-craft Inter-face #1 (1331144)	MISSION	May provide operational data but not status	No effect	Inability to assess operational status data	Hi-Rel Parts and Design, Test and Inspection are imposed	III	Remote
			2. Failure in Space-craft Inter-face #2 (1331147)	MISSION	Same as above	Same as above	Same as above	Same as above	III	Remote
	f. Analog Telemetry Output	Provide for analog housekeeping and switched thermistor outputs	MODE Short on any analog telemetry signal							
			CAUSE 1. Failure in Space-craft Inter-face #1 (1331144)	MISSION	No useful analog telemetry data	Degraded mission	Inability to assess analog telemetry data	Hi-Rel Parts and Design, Test and Inspection are imposed	III	Remote
			2. Failure in Space-craft Inter-face #2 (1331147)	MISSION	Same as above	Same as above	Same as above	Same as above	III	Remote

Section A2

Module A2 to Spacecraft Interface
FMEA Worksheets

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level A2 - S/C Interface
Reference Drawing See GIRD/UIID

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	Mechanical	Provides direct base mount attachment of the AMSU-A2 module to the spacecraft	See analysis for A1							
	Thermal interface	Minimize heat flow between the A2 module and the spacecraft	See analysis for A1							

Failure Modes and Effects Analysis

System EOS/ONLY
Indenture Level A2 - S/C Interface
Reference Drawing See GIRD/UIID

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	Electrical interfaces to AMSU-A2 spacecraft Input power	Provide +28 VDC main power, and +28V analog temperature telemetry	See analysis for A1							

Failure Modes and Effects Analysis

System METSAT ONLY
Indenture Level A2 - S/C Interface
Reference Drawing See GIRD/UIID

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	Electrical Interfaces EOS/AMSU-A2 to space-craft									
	a. Input Power	Provide +28 VDC main power, +28V pulse load power, and +28V analog temperature telemetry	See analysis for A1							
	b. Clock Input	Provide 1.248 MHZ clock for timing all AMSU-A functions	See analysis for A1							
	c. Command Input	Provides +10V interface power and return in addition to 14 level discrete commands for A1	See analysis for A1							
	d. TIP Interface	Provides for select pulse (A_1) and shift pulse (C_1) from spacecraft, digital A output major frame sync, and signal return	See analysis for A1							
	e. Digital B Output	Provides for monitoring of command and instrument operational status using 9 bi-level outputs	See analysis for A1							
	f. Analog Telemetry Output	Provide for analog housekeeping and switched thermistor outputs	See analysis for A1							

Section A3

Electronics Subsystem Interface
FMEA Worksheets

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1 Electronics	The electronics provides radiometric temperature, thermometric temperature, and house-keeping data at levels and in a format compatible with the spacecraft. It also provides command processing and control timing for all periodic functions in the module.	MODE Malfunc-tion in electrical interfaces to spacecraft CAUSE See A1 S/C Interface Analyses MODE Reduction or loss of data on any single channel 3-15							
			CAUSE Malfunc-tion or failure in one of the following compon-ents in the respective channel							
			1. Video amplifier offset (1331157)	MISSION	Loss of data in a single channel	Degraded mission	Low levels on a single channel 3-15	High reliability components	III	Remote
			2. I&D filter (1338424)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/ONLY
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1 Electronics		MODE Loss of radio-metric data on all 13 channels CAUSE Malfunc-tion or failure in one of the following compon-ents:							
			1. Analog Multi-plexer /AD converter (1356418)	MISSION	No useful EOS/ AMSU-A data on the 13 channels.	Significant degrada-tion of mission.	Operation-al status	High reliability components	I	Extremely unlikely*
			2. Memory (1331126)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Timing control generation (1331135)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. CPU (1356413)	MISSION	No useful AMSU-A data on the 13 channels	Significant degrada-tion of mission	Operation-al status	High reliability components	I	Extremely unlikely
			5. Scan control (1331129)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			6 MIL-STD-1553 (1355998)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			7. DC/DC Converter (1356010-1)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

* Required for performance. Procured to Aerojet specification, that requires qualification and acceptance testing including performance, vibration, shock, acceleration, thermal cycling, and burn-in as applicable. It also includes flow down of requirements for parts, materials, and processes control; e.g., standard parts and NHB 5300.4(3A-1)

Failure Modes and Effects Analysis

System METSAT ONLY
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1 Electronics									
			MODE Loss of radio-metric data on all 13 channels							
			CAUSE Malfunc-tion or failure in one of the following compon-ents							
			1. Analog Multiplexer/ A/D Converter (1356418)	MISSION	No useful AMSU-A data on the 13 channels	Significant de-gradation of mission	Operations status	High reliability components	I	Extremely Unlikely
			2. Memory	MISSION	Same as above	Same as above	Same as above	Same as above	I	Extremely Unlikely
			3. Timing Control Genera-tion)	MISSION	Same as above	Same as above	Same as above	Same as above	I	Extremely Unlikely
			4. CPU (1331123)	MISSION	No useful AMSU-A data on all 13 channels	Significant degrada-tion of mission	Operation-al status	High reliability components	I	Extremely Unlikely
			5. Scan Control (1331129))	MISSION	Same as above	Same as above	Operation-al status	Same as above	I	Extremely Unlikely
			6. Mother Board (1331153)	MISSION	Same as above	Same as above	Operation-al status	Same as above	I	Extremely Unlikely
			7. Parallel to Serial Converter	MISSION	Same as above	Same as above	Operation-al status	Same as above	I	Extremely Unlikely
			8. Serial spacecraft interface (1331147 and 133144)	MISSION	Same as above	Same as above	Operation-al status	Same as above	I	Extremely Unlikely
			9. DC/DC converter (1356010-1)	MISSION	Same as above	Same as above	Operation-al status	Same as above	I	Extremely Unlikely

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1 Electronics		MODE Beam position data stuck or erratic							
			CAUSE 1. Failure in motor control circuitry.	See antenna subsystem analysis	See antenna subsystem analysis	See antenna subsystem analysis	Operational status			
			2. Malfunction or failure in any of the following components:				Operational status			
			Scan control (1331129)	MISSION	Incomplete data transfer.	Some degradation of mission.	Beam position data not consistent with radiometric data sequence.	High reliability circuitry	III	Extremely unlikely
			Timing control generator (1331135)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			Command signal wiring backplane	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/ONLY
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1 Electronics		Mode Loss of any serial readout data							
			CAUSE Malfunc-tion or failure in:	MISSION	No useful data from channels 3-15.	Significant degrada-tion of mission.	Telemetry voltage status	High reliability circuitry	I	Extremely unlikely
			1. MIL-STD-1553 interface (1355998)	MISSION	No useful data from channels 3-15.	Significant degrada-tion of mission.	Telemetry voltage status	High reliability circuitry	I	Extremely unlikely
			2. Timing control generation (1331135)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System METSAT/ONLY
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1 Electronics		Mode Loss of any serial readout data							
			CAUSE Malfunc-tion or failure in:	MISSION	No useful data from channels 3-15.	Significant degrada-tion of mission.	Telemetry voltage status	High reliability circuitry	I	Extremely unlikely
			1. Parallel to serial converter (1331150))	MISSION	No useful data from channels 3-15.	Significant degrada-tion of mission.	Telemetry voltage status	High reliability circuitry	I	Extremely unlikely
			2. Timing Control Genera-tion (1331135)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Extremely unlikely

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1 Electronics		Mode Electrical Inter-mittent							
			CAUSE Fracture of printed circuit traces or plated through hole.	MISSION	Worst effect is no useful data on channels 3-15.	Extremely degraded mission.	Inter-mittent or erratic output data	Reliable circuit certified processes	I	Remote

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2 Electronics	See A1 Electronics description	MODE Reduction or loss of data on any single channel 1 & 2.							
			CAUSE Malfunc-tion or failure in one of the following compon-ents in the respective channel:							
			1. Video amplifier/ offset (1331157)	MISSION	Loss of data in a single channel.	Degraded mission	Low levels on a single channel 1 or 2.	High reliability components	III	Remote
			2. I&D filter (1331676)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. DC/DC Converter (1356010-1)	MISSION	Loss of Signal Processing	Loss of mission	No data	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/ONLY
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2 Electronics		MODE Loss of radio-metric data on both 1 & 2 channels. CAUSE Malfunc-tion or failure in one of the following compon-ents:							
			1. Analog Multi-plexer /AD converter (1356418)	MISSION	No useful EOS/ AMSU-A data on the 2 channels	Degraded mission	Operation-al status data	High reliability components	II	Extremely unlikely*
			2. Memory (1331126)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Timing control generation (1331135)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. CPU (1356413)	MISSION	No useful AMSU-A data on the 2 channels	Degraded mission	Operation-al status data	High reliability components	II	Extremely unlikely
			5. Scan control (1331129)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			6. MIL-STD 1553 interface (1355998)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

* Required for performance. Procured to Aerojet specification, that requires qualification and acceptance testing including performance, vibration, shock, acceleration, thermal cycling, and burn-in as applicable. It also includes flow down of requirements for parts, materials, and processes control; e.g., standard parts and NHB 5300.4(3A-1)

Failure Modes and Effects Analysis

System METSAT ONLY
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2 Electronics	See A1 Electronics Description	MODE Loss of radio-metric data on both 1 & 2 channels							
			CAUSE Malfunc-tion or failure in one of the following compon-ents							
			1. Analog Multiplexer/ A/D Converter (1356418)	MISSION	No useful AMSU-A data on the 2 channels	Degraded mission	Operations status data	High reliability components	II	Extremely Unlikely
			2. Memory (1331126)	MISSION	Same as above	Same as above	Same as above	Same as above	II	Extremely Unlikely
			3. Timing Control Genera-tion (1331135)	MISSION	Same as above	Same as above	Same as above	Same as above	II	Extremely Unlikely
			4. CPU (1356413)	MISSION	No useful AMSU-A data on the 2 channels	Degraded mission	Operation-al status data	High reliability components	II	Extremely Unlikely
			5. Scan Control (1331129))	MISSION	Same as above	Same as above	Operation-al status	Same as above	II	Extremely Unlikely
			6. Mother Board (1331153)	MISSION	Same as above	Same as above	Operation-al status	Same as above	II	Extremely Unlikely
			7. Parallel to Serial Converter (1331150)	MISSION	Same as above	Same as above	Operation-al status	Same as above	II	Extremely Unlikely

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2 Electronics		MODE Beam position data stuck or erratic							
			CAUSE 1. Failure in motor control circuitry	See antenna subsystem analysis	See antenna subsystem analysis	See antenna subsystem analysis				
			2. Mal-function or failure in any of the following compon-ents:							
			Scan control (1331129)	MISSION	In-complete data transfer	Degraded mission	Beam position data not consistent with radio-metric data sequence.	High reliability circuitry	III	Extremely unlikely
			Timing control generator (1331135)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			Command signal wiring backplane	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/ONLY
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2 Electronics		Mode Loss of any serial readout data							
			CAUSE Malfunc-tion or failure in	MISSION	No useful data from channels 1 & 2.	Degraded mission	Telemetry voltage status	High reliability circuitry	II	Extremely unlikely
			1. MIL-STD-1553 interface (1355998)							
			2. Timing control generation (1331135)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System METSAT/ONLY
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2 Electronics		Mode Loss of any serial readout data							
			CAUSE Malfunc-tion or failure in:	MISSION	No useful data from channels 1 & 2	Degraded mission	Telemetry voltage status	High reliability circuitry	II	Extremely unlikely
			1. Parallel to serial converter (1331150)							
			2. Timing Control Genera-tion (1331135)	MISSION	Same as above	Same as above	Same as above	Same as above	II	Extremely unlikely

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Electronics Subsystem
Reference Drawing AE-26609

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2 Electronics		Mode Electrical Inter-mittent							
			CAUSE Fracture of printed circuit traces or plated through hole.	MISSION	Worst effect is not useful data on channels 1 & 2.	Extremely degraded mission	Inter-mittent or erratic output data.	Reliable circuit certified processes	II	Remote

Section A4

Receiver Subsystem Interface FMEA Worksheets

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Receiver Subsystem
Reference Drawing AE-26608

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1 Receiver	The receiver circuits convert microwave energy to IF frequencies which are amplified, bandpass filtered, and detected prior to processing in the video circuits.	MODE Reduction or loss of any single channel 6, 7 or 15. CAUSE Malfunc-tion or failure in one of the following compon-ents.							Remote
			1. Isolator (1356680)	MISSION	Loss of data in a single channel.	Degraded mission	Low levels on a single channel 6, 7, or 15.	High reliability components	III	Remote
			2. Stable Oscillator (1336610)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Mixer/IF Amp (1331562)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. Wave-guide attenuator (1331509)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			5. Band-pass filter (1331559)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			6. IF attenuator (1331516)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			7. Detector (1331577)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Receiver Subsystem
Reference Drawing AE-26608

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1 Receiver		MODE Reduction or loss of all channels 9-14. CAUSE Malfunc-tion or failure in one of the following compon-ents:							Remote
			1. Isolator (1356680)	MISSION	Low levels or loss of data on all 6 channels	Significant degrada-tion of mission	Low levels on all 6 channels	High reliability components	II	Remote
			2. Hybrid tree (1331554)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Remote*
			3. PLO (1348360)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Remote
			4. Mixer/ IF amplifier (1331562)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			5. Wave-guide attenuator (1331509) (1331510)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			6. 3-way Power divider (1356669)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

* Redundant PLO

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Receiver Subsystem
Reference Drawing AE-26608

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1 Receiver		MODE Reduction or loss in either channel 9 or 10. CAUSE Malfunc-tion or failure in one of the following compon-ents on the respective channel.							Remote
			1. IF bandpass filter (1331559)	MISSION	Loss of data in a single channel.	Degraded mission	Low levels on a single channel 9 or 10.	High reliability components	III	Remote
			2. IF amplifier (1331579)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. I F attenuator (1331516)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. Detector (1331577)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Receiver Subsystem
Reference Drawing AE-26608

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1 Receiver		MODE Reduction or loss all channels 11-14 CAUSE Malfunc-tion or failure in one of the following compon-ents:							Remote
			1. IF amplifier (1331579)	MISSION	Loss of data on all four channels	Degraded mission	Low levels on all 4 channels	High reliability components	II	Remote
			2. 4-Way Power divider (1336670)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			MODE Reduction or loss in any single channel 11-14							
			CAUSE Malfunc-tion or failure in one of the following compon-ents in the respective channel							
			1. SAW filter (1331576)	MISSION	Loss of data in a single channel.	Degraded mission	Low levels on single channel 11, 12, 13, 14	High reliability components	II	Remote
			2. IF amplifier (1331579) 1 thru 12	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. IF attenuator (1331516)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. Detector (1331577)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Receiver Subsystem
Reference Drawing AE-26608

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1 Receiver		MODE High current drain on DC/DC converter							
			CAUSE Leaky or shorted filter capacitor	MISSION	Higher power dissipation as a minimum worst case is loss of all channels 6, 7, 9-15	Significant degraded mission	Drop in monitored DC voltage level	High reliability components	II	Remote
			MODE Fracture of any wave-guide							
			CAUSE Loosening or fracture of mounting hardware	MISSION	Worst effect is loss of ability to control signal gain	Degraded mission	Reduction in signal strength	Hardware uses lock nuts or solithane	II	Remote

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Receiver Subsystem
Reference Drawing AE-26608

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1 Receiver	The receiver circuits convert microwave energy to IF frequencies which are amplified, bandpass filtered, and detected prior to processing in the video circuits	MODE Reduction or loss of any single channel 3, 4, 5, 8. CAUSE Malfunc-tion or failure in one of the following compon-ents:							
			1. Isolator (1356680)	MISSION	Loss of data in a single channel	Degraded mission	Low levels on a single channel 3, 4, 5, or 8	High reliability components	III	Remote
			2. Local Oscillator (1336610)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Mixer/ IF amplifier (1331562)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. Wave-guide attenuator (1331509)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			5. Band pass filter (1331559)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			6. IF attenuator (1331516)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			7. Detector (1331577)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Receiver Subsystem
Reference Drawing AE-26608

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-2 Receiver		MODE High current drain on DC/DC converter.							
			CAUSE Leaky or shorted filter capacitor.	MISSION	Higher power dissipation as a minimum. Worst case is loss of all channels 3,4,5,8	Significant degraded mission	Drop in monitored DC voltage level.	High reliability components	II	Remote
			MODE Fracture of any waveguide							
			CAUSE Loosening or fracture of mounting hardware	MISSION	Worst case is loss of ability to control signal gain	Degraded mission	Reduction in signal strength	Hardware uses lock nuts or solithane Design with safety factor uses adequate thread insertion. Use qualified hardware only.		

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Receiver Subsystem
Reference Drawing AE-26608

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2 Receiver	The receiver circuits convert microwave energy to IF frequencies which are amplified, bandpass filtered, and detected prior to processing in the video circuits.	MODE Reduction or loss of any single channel 1 or 2							
			CAUSE See analysis for A1 No. 2 receiver other than Isolator (1331111 or 1331112) and Wave-guide Attenuator (1331100). Others are the same as 1356409	MISSION	Loss of data in a single channel	Degraded mission	Low levels on a single channel 1 or 2	High reliability components	III	Remote

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Receiver Subsystem
Reference Drawing AE-26608

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2 Receiver		MODE High current drain on DC/DC converter							
			CAUSE Leaky or shorted filter capacitor	MISSION	Higher power dissipation as a minimum. Worst case is loss of both channels 1 and 2.	Degraded mission	Drop in monitored DC voltage level.	High reliability components	II	Remote
			MODE Fracture of any wave-guide							
			CAUSE Loosening or fracture of mounting hardware	MISSION	Worst effect is loss of ability to control signal gain.	Degraded mission	Reduction in signal strength	Hardware uses lock nuts or solithane. Design with safety factor uses adequate thread insertion. Use qualified hardware only.	II	Remote

Section A5

Antenna Subsystem Interface
FMEA Worksheets

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1 Antenna Drive/ Calibration	The antenna receives microwave radiometric energy, warm and cold calibration references in step sequence. The energy is separated in an orthogonal mode transducer (OMT) and supplied as polarized inputs to the receiver.	MODE Reduction or loss of microwave energy in channels 6, 7, 9-15 CAUSE Distortion or failure of rotating reflector (1355776)	MISSION	Degradation or loss of sensitivity	Degradation of mission	Output data on channels 6, 7, 9-15 shifting	Rigid, simple design, weld inspected unit tested	II	Remote
			Distortion or failure of feed horn & associated wave guides (1331361)	MISSION	Same as above	Same as above	Same as above	Rigid, simple design, unit inspected and tested	II	Remote
			MODE Reduction or loss of microwave energy in either the vertically polarized channels 6 and 15 or horizontally polarized channels 7 and 9-15							
			CAUSE Distortion or failure of orthogonal mode transducer (1331546)	MISSION	Same as above but limited to vertically or horizontally polarized channels	Same as above	Output data on channels 6 & 15 or channels 7 & 9-15 shifting	Rigid simple design, unit inspected and tested	II	Remote

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1		MODE Constant signal							
			CAUSE Malfunc-tion or failure in one of the following compon-ents							
			1. Reflector (stuck) (1355776)	MISSION	Loss of data from channels 6, 7, 9-15	Extremely degraded mission	Absence of warm/ cold reference and scene data sequences no beam position data	Design derating, high reliability parts, qualification testing, and inspection requirements imposed	II	Occasional
			2. Motor (1331392)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Motor Driver (1331694)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. Resolver (1331529)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			5. R/D Converter Oscillator (1337739)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			6. Inter-face converter (1331697)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			7. Resolver data isolator (1334972)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1		MODE Loss or erroneous antenna position data							
			CAUSE Malfunc-tion or failure in one of the following compon-ents							
			1. Resolver	MISSION	Loss of capability to accurately determine scan position	Degraded mission	Telemetry data on antenna position	Design derating high reliability parts, qualifi-cation testing and inspection requirements imposed	II	Remote*
			2. R/D Converter Oscillator (1337739)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Inter-face con-verter (1331697)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. Resolver data isolator (1334972)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

* It may be possible for the system to interpolate from warm/cold calibrate and thermal data sequence.

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1		MODE High current drain on +28 VDC pulse load (noisy bus)							
			1. Cable short	MISSION	Increased power dissipation as a minimum worst case is complete loss of data on channels 6, 7, 9-15	Extremely degraded mission	Analog housekeeping telemetry	Design, inspection, and test requirements are imposed	II	Remote*
			2. Filter pin fault (1331712)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Scan drive input circuitry including bus selection circuit short (1356002)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Extremely unlikely
			4. Motor short (1331392)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Occasional
			5. Motor driver short (1331694)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Occasional

* For causes 1, 2, and 3, short would result in automatic switching to redundant bus.

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1		MODE Loosening or separation of motor from mounting bulkhead							
			CAUSE Loosening or fracture of mounting bolts	MISSION	If binding occurs, then antenna beam position is affected. Worst case is useless for channels 6, 7, 9-15.	Extremely degraded mission	None unless severe enough to cause binding of reflector then motor current will be higher.	Hardware uses lock nuts or solithane. Design with safety factor use adequate thread insertion. Use qualified hardware only.	II	Extremely unlikely

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-1		MODE Loosening or separation of other antenna components (feed horn, MUX, warm load)	MISSION						
			CAUSE Same as above		Same as above	Same as above	Same as above	Hardware uses lock nuts or solithane. Design with safety factor use adequate thread insertion. Use qualified hardware only.	II	Extremely unlikely

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-2 Antenna Drive/ Calibration	See A1-1 Description	MODE Reduction or loss of micro-wave energy in channels 3, 4, 5, & 8 CAUSE Distortion or failure of rotating reflector (1355776)	MISSION	Degrada-tion or loss of sensitiv-ity	Degrada-tion of mission	Output data on channels shifting	Rigid, simple design, weld inspected unit tested	II	Remote
			Distortion or failure of feed horn & associated wave-guides (1331361)	MISSION	Same as above	Same as above	Same as above	Rigid, simple design, unit inspected and tested	II	Remote
			MODE Reduction or loss of micro-wave energy in either the vertically polarized channels or horizon-tally polarized channels	MISSION						
			CAUSE Distortion or failure of ortho-gonal mode trans-ducer (1331507)		Same as above but limited to vertically or horizon-tally polarized channels	Same as above	Output data on channels 6 & 15 or channels shifting	Rigid simple design, unit inspected and tested	II	Remote

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-2		MODE Constant signal							
			CAUSE Malfunc-tion or failure in one of the following com-ponents							
			1. Reflector (stuck) (1355776)	MISSION	Loss of data from channels 3, 4, 5, 8	Extremely degraded mission	Absence of warm/ cold reference and scene data sequences no beam position data	Design derating, high reliability parts	II	Occasional
			2. Motor (1331392)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Motor Driver (1331694)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. Resolver (1331529)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			5. R/D Converter Oscillator (1337739)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			6. Inter-face converter (1331697)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			7. Resolver data isolator (1334972)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-2		MODE Loss of erroneous antenna position data							
			CAUSE Malfunc-tion or failure in one of the following compon-ents:							
			1. Resolver (1331529)	MISSION	Loss of capability to accurately determine scan position	Degraded mission	Telemetry data on antenna position	High reliability part	II	Remote*
			2. R/D Converter Oscillator (1337739)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Inter-face con-verter (1331697)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. Resolver data isolator	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

* It may be possible for the system to interpolate from warm/cold calibrate and thermal data sequence.

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-2		MODE High current drain on +28 VDC pulse load (noisy bus)							
			1. Cable short	MISSION	Increased power dissipation as a minimum worst case is complete loss of data on channels 6, 7, 9-15	Extremely degraded mission	Analog housekeeping telemetry	Design, inspection, and test requirements are imposed	II	Remote*
			2. Filter pin fault (1331712)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Scan drive input circuitry including bus selection circuit short (1356002)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Extremely unlikely
			4. Motor short (1331392)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Occasional
			5. Motor driver short (1331694)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Occasional

* For causes 1, 2, and 3, short would result in automatic switching to redundant bus.

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-2		MODE Loosening or separation of motor from mounting bulkhead							
			CAUSE Loosening or fracture or mounting bolts	MISSION	If binding occurs, then antenna beam position is affected. Worst case is loss of channels 3, 4, 5, 8	Extremely degraded mission	None unless severe enough to cause binding of reflector then motor current will be higher.	Hardware uses lock nuts or solithane. Design with safety factor use adequate thread insertion. Use qualified hardware only.	II	Extremely unlikely

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A1-2		MODE Loosening or separation of other antenna components (feed horn, MUX, warm load).	MISSION						
			CAUSE Same as above		Same as above	Same as above	Same as above	Hardware uses lock nuts or solithane. Design with safety factor use adequate thread insertion. Use qualified hardware only.	II	Extremely unlikely

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2 Antenna Drive/ Calibration	The antenna receives microwave radiometric energy, warm and cold calibration references in step sequence. A single feed and low-loss diplexer provides the channels 1 & 2 signals.	MODE Reduction or loss of micro-wave energy in channels 1 & 2 CAUSE Distortion or failure of rotating reflector (PN TBD)	MISSION	Degrada-tion or loss of sensitiv-ity.	Degrada-tion of mission.	Output data on channels 1 & 2 shifting.	Rigid, simple design, composite reflector inspected unit tested.	II	Remote
			Distortion or failure of feed horn & associated wave guides (1331231)	MISSION	Same as above	Same as above	Same as above	Rigid, simple design.	II	Remote
			Distortion or failure of diplexer (1331084)	MISSION	Same as above	Same as above	Same as above	Rigid, simple design. Qual & acceptance tested per Specification AE-24688	II	Remote

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2		MODE Constant signal							
			CAUSE Malfunc-tion or failure in one of the following com-ponents							
			1. Reflector (stuck) (1333225)	MISSION	Loss of data from channels 1 & 2.	Extremely degraded mission.	Absence of warm/ cold reference and scene data sequences no beam position data.	Design derating, high reliability parts, qualification testing, and inspection requirements imposed.	II	Occasional
			2. Motor (1333648)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Motor Driver (1331694)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. Resolver (1331529)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			5. R/D Converter Oscillator (1337739)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			6. Inter-face converter (1331697)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			7. Resolver data isolator (1334972)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2		MODE Loss of erroneous antenna position data							
			CAUSE Malfunc-tion or failure in one of the following compon-ents							
			1. Resolver (1331529)	MISSION	Loss of capability to accurately determine scan position	Degraded mission	Telemetry data on antenna position	High reliability part	II	Remote*
			2. R/D Converter Oscillator (1337739)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Inter-face con-verter (1331697)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			4. Resolver data isolator (1334972)	MISSION	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above

* It may be possible for the system to interpolate from warm/cold calibrate and thermal data sequence.

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level A2 Antenna
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2		MODE High current drain on +28VDC pulse load (noisy bus)							
			1. Cable short	MISSION	Increased power dissipation as a minimum worst case is complete loss of data on channels 1 & 2	Extremely degraded mission	Analog housekeeping telemetry	Design, inspection, and test requirements are imposed	II	Remote*
			2. Filter pin fault (1331319)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
			3. Scan drive input circuitry including bus selection circuit short (1356002)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Extremely unlikely
			4. Motor short (1333648)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Occasional
			5. Motor driver short (1331694)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Occasional

* For causes 1, 2, and 3, short would result in automatic switching to redundant bus.

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2		MODE Loosening or separation of motor from mounting bulkhead.							
			CAUSE Loosening or fracture or mounting bolts.	MISSION	If binding occurs, then antenna beam position is affected. Worst case is useless channels 1 & 2.	Extremely degraded mission.	None unless severe enough to cause binding of reflector then motor current will be higher.	Hardware uses lock nuts or solithane. Design with safety factor use adequate thread insertion. Use qualified hardware only.	II	Extremely unlikely

Failure Modes and Effects Analysis

System EOS/METSAT
Indenture Level Antenna Subsystem
Reference Drawing AE-26607

ID No.	Item/ Funct. ID	Function	Failure Modes & Causes	Mission Phase/Op. Mode	Failure Effects		Failure Detect. Mtd.	Compensating Provisions	Severity Class	Failure Prob.
					Next Higher Level	Mission Effects				
	A2		MODE Loosening or separation of other antenna components (feed horn, MUX, warm load).	MISSION						
			CAUSE Same as above		Same as above	Same as above	Same as above	Hardware uses lock nuts or solithane. Design with safety factor use adequate thread insertion. Use qualified hardware only.	II	Extremely unlikely

APPENDIX B

INTEGRATED ADVANCED MICROWAVE SOUNDING UNIT-A (AMSU-A)

CRITICAL ITEMS LIST

for EOS/METSAT

Contract No: NAS 5-32314
CDRL: 507

FINAL SUBMITTAL

CRITICAL ITEM LIST

This Critical Item List (CIL) for the EOS and METSAT AMSU-A instruments provides a list of those items that are considered critical. The list provides the justification and compensating provisions that are utilized to reduce or eliminate the effects of each critical item on AMSU-A performance or reliability.

Critical Item Definition

A critical item is defined as any item whose severity category is identified as being a potentially catastrophic (Criticality 1) or critical (Criticality 2) failure.

Critical Items List

The Critical Items List (Table B-1) is in contractor format - columnar form with Item, Description, Drawing Number, and Severity Category, and includes Justification/Compensation provisions. Items unique to either EOS or METSAT are identified as to location in the description column.

Severity Levels

Identification of mission-critical items is provided on each worksheet by assigning a severity category to each failure mode. The severity classifications are as defined in PAR GSFC-S-480-79, Paragraph 7.3.1.

I	Criticality 1.- A single failure that could result in loss of human life or serious injury to personnel, or loss of a launch facility, the launch vehicle, or a primary mission objective. For failures involving potential loss of life or serious injury to personnel, redundant design, both of which if failed would result in a Criticality 1 failure, shall be considered Criticality 1.)
II	Criticality 2.- A single failure that could result in damage to a launch facility or launch vehicle, significant degradation of science products (as defined by the Project), or loss of a secondary mission objective.
III	Criticality 3.- Loss of redundancy or an effect less severe than that of a Criticality 2 failure mode.

Table B-1 Critical Items List

Item #	Description	Drawing Number	Severity	Justification/Compensation Provisions
1	A/D Converter Analog Multiplexer	1356418 (AE-26123)	I	Required to meet design criteria/Procured to Aerojet specifications that flow down the necessary requirements for procurement of a high reliability part. Stress analysis verifies that parts are derated well within requirements. A Destructive Physical Analysis (DPA) will be performed to confirm the acceptability of the manufacturer's processes. Submitted to GSFC as NSPAR 081 on NOAA/AMSU Program.
2	Memory	1331126 CCA	I	Required to meet design criteria /Use high reliability parts, apply derating per PPL-20 and MIL-STD-975. Stress analysis verifies parts derated well within requirements. Use polyamide material for the CCA' (designed to GSFC approved requirements) and procure to drawings and specifications that flow down requirements to control manufacturing. Extensive subassembly level testing, including thermal cycling.
3	Timing and Control	1331135 CCA	I	Same as item 2
4	CPU	1356413 CCA	I	Same as Item 2
5	Scan Control	1331129 CCA	I	Same as Item 2
6	Cable		I	Design, inspect, and test to EOS/AMSU-A requirements. Use qualified material. Fabricate and assemble to approved procedures.
7	Filter Pin Connector	1331712 1331719	I	Procure to controlled requirements 100% inspection of connectors filter pins; use connector savers.
8	DC/DC Converter	1356010 (AE-26577)	I	Required to meet design criteria/Procured to Aerojet specification that requires qualification and acceptance testing; includes performance and environmental testing. Also includes flow down of applicable parts, materials, and processes requirements.
9.	Filter Capacitor		II	Required to meet design criteria/procured to high reliability requirements. Stress analysis verifies parts derating within requirements.
10	Bolts		II	Required to meet design criteria/Procured to controlled requirements, derated with design safety margins controlled torque requirements; required thread engagement. Note: Does not include S/C interface bolts furnished and controlled by spacecraft contractor.
11	MIL-STD-1553 Interface (EOS)	1355998 CCA	I	Same as Item #2
12	Rotating Reflector Assembly	1333647 1333651	II	Use rigid simple design and inspection; unit tested as subassembly; procure to defined and approved drawings and specifications.
13	Feed Horn & Waveguide Assemblies	1331410 1331361 1331231	II	Same as Item #12
14	5-Port Multiplexer (Orthogonal Mode Transducer)	1331546	II	Same as Item #8
15	Reflector (A1)	1355776	II	Same as Item #12
16	Reflector (A2)	1355835	II	Same as Item #12
17	Motor	1331392 (AE-24690) 1333648 (AE-26052)	II	Same as Item #8

Table B-1 Critical Items List Cont.

Item #	Description	Drawing Number	Severity	Justification/Compensation Provisions
18	Motor Driver Assembly CCA	1331694	II	Same as Item #2
19	Resolver	1333638	II	Same as Item #8
20	R/D Converter Oscillator	1337739	II	Same as Item #1 Submitted to GSFC as NSPAR NA028 on NOAA/AMSU Program
21	Interface Converter CCA	1331697	II	Same as Item #2
22	3 Port Diplexer	1331084 (AE-24688)	II	Same as Item #8
23	W.G. Isolator	1331111 1331112 1356680 (AE-26025)	II	Same as Item #8
24	V-Band Hybrid Tee	1331554 (AE-25022)	II	Same as Item #8
25	Phase-Locked Oscillator	1348360 (AE-26633)	II	Same as Item #8
26	I.F. Amplifier	1331579 (AE-24684)	II	Same as Item #8
27	I.F. Power Dividers	1356669 1356690 (AE-24867)	II	Same as Item #8
28	I.F. Filter	1331559 (AE-24687)	II	Same as Item #8
29	I.F. Attenuator	1331516 (AE-24868)	II	Same as Item #8
30	R.F. Detector	1331577 (AE-24694)	II	Same as Item #8 Submitted to GSFC as NSPAR AC032 on NOAA/AMSU Program
31	SAW Filter	1331576 (AE-24937)	II	Same as Item #8
32	Parallel to Series Converter CCA (METSAT)	1331150	I	Same as Item #2
33	S/C Interface #1 CCA (METSAT)	1331144	II	Same as Item #2
34	S/C Interface #2 CCA (METSAT)	1331147	II	Same as Item #2
35	Compensation Motor (METSAT)	1333550	II	Required to meet design criteria/Procured to Aerojet specification that requires Qualification and Acceptance testing; includes performance and environmental testing. Also includes flow down of applicable parts, materials, and processes.
36	GDO Ultra Stable (METSAT)	1331553 (AE-24683	II	Required to meet design criteria/Procured to Aerojet specification that requires Qualification and Acceptance testing; includes performance and environmental testing. Also includes flow down of applicable parts, materials, and processes.

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DOCUMENT APPROVAL SHEET

TITLE	DOCUMENT NUMBER
Meteorological Satellite (METSAT) and Earth Observing System (EOS) Advanced Microwave Sounding Unit A (AMSU-A) Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL)	Report 10378 March 1996

INPUT FROM:	DATE	CDRL:	SPECIFICATION ENGINEER:	DATE
		108/507	R. Regehr	14 Mar 96

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APPROVAL SIGNATURES	DEPT. NO.	DATE
Technical Director/DPM (R. Hauerwaas) R V Hauerwaas	4001	3/15/96
Performance Assurance (R. Taylor) R M Taylor	5331	3-15-96
Configuration Management (J. Cavanaugh) J Cavanaugh	8611	3-15-96

By my signature, I certify the above document has been reviewed by me and concurs with the technical requirements related to my area of responsibility.

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Please return this sheet and the reproducible master to the Data Center (119/8651), ext. 2231.

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